# REMEDIAL INVESTIGATION REPORT FOR HIGH PRIORITY SITES (881 HILLSIDE AREA)

## VOLUME V
## (APPENDICES F AND G)

*U.S. DEPARTMENT OF ENERGY*
*ROCKY FLATS PLANT*
*GOLDEN, COLORADO*
*JULY 1, 1987*

**ROCKWELL INTERNATIONAL**
NORTH AMERICAN SPACE OPERATIONS
ROCKY FLATS PLANT

UNITED STATES DEPARTMENT OF ENERGY
ADMINISTRATION CONTRACT DE-AC04-76DP03533

REVIEWED FOR CLASSIFICATION/UCNI
By [signature]
Date 12/16/91

ADMIN RECORD

A-OU01-000258

# APPENDIX F

# QUALITY ASSURANCE

# APPENDIX F

# QUALITY ASSURANCE

## 1.0 INTRODUCTION

The Quality Assurance (QA) Program consists of policies, objectives, principles, and general procedures to be followed in producing environmental data. The entire QA Plan followed in the remedial investigation is contained in the Remedial Investigation Plan (DOE, 1987a) of the Comprehensive Environmental Assessment and Response Program (CEARP). Its intent, through the use of function-related audits, is to document compliance or identify nonconformance with established procedural requirements for both field and laboratory activities. The QA Plan also addresses the implementation of corrective actions necessary to remedy the identified nonconformances or to establish any technically necessary deviations from the monitoring plan.

### 1.2 Field Quality Assurance

Unannounced field audits, investigating conformance with specified procedures, were frequently performed during this remedial investigation (RI). Two types of audits were performed; a generic audit form was used as an overall audit of RI activities. This generic audit form is provided in Table F-1.

Detailed audit forms were designed for each technical activity. These detailed audit forms were developed by extracting technical specifications from each procedure and organizing them in their order of implementation for that activity. All the field activities were audited in this fashion. Copies of these audit records are found in Appendix F.1.

Table F.1. Field Audit

Project_____ Site Manager_____

Site Location_____ Field Team Leader_____

Auditor_____ Date_____

| Audit Question | Yes | No | Comment/Documentation |
|---|---|---|---|
| 1. Was a site-specific sampling and analytical plan followed? | | | |
| 2. Was a field team leader appointed? | | | |
| 3. Was the site health and safety coordinator present? | | | |
| 4. Were field team members familiar with the sampling plan? | | | |
| 5. Was a briefing held offsite, before any site work was begun, to acquaint personnel with sampling equipment and assign field responsibilities? | | | |
| 6. Was the daily briefing and safety check conducted? | | | |
| 7. Was a completed "Site Personnel Protection and Safety Evaluation Form" read and signed by all visitors and personnel entering the site? | | | |
| 8. Was a field notebook assigned to the field team leader? | | | |
| 9. Were entries made in the field notebook? | | | |
| 10. Were sampling stations located correctly? | | | |
| 11. Did the number and location of samples collected follow the site-specific sampling plan? | | | |

Table F.1. (Continued)

Project _____ Site Manager _____

Site Location _____ Field Team Leader _____

Auditor _____ Date _____

| Audit Question | Yes | No | Comment/Documentation |
|---|---|---|---|
| 12. Were samples identified as described in the site-specific sampling plan? | | | |
| 13. Were samples collected following procedures specified in the site-specific plan? | | | |
| 14. Was a chain-of-custody form filled out for all samples collected? Were all sample transfers documented? | | | |
| 15. Were samples preserved as specified in the site-specific sampling plan? | | | |
| 16. Were the number, frequency, and type of samples (including blanks and duplicates) collected as described in the site-specific sampling plan? | | | |
| 17. Were the number, frequency, and type of measurements and observations taken as specified in the site-specific sampling plan? | | | |
| 18. Were blank and duplicate samples properly identified? | | | |
| 19. Was a record maintained of calibration of field equipment? | | | |
| 20. Was field equipment calibrated as required? | | | |

Table F.1. (Continued)

Project _____ Site Manager _____

Site Location _____ Field Team Leader _____

Auditor _____ Date _____

| Audit Question | Yes | No | Comment/Documentation |
|---|---|---|---|
| 21. Have any procedures been revised? | | | |
| 22. Are revisions to procedures adequately documented? | | | |
| 23. Was the document log for chain-of-custody records and other sample traffic control forms maintained? | | | |
| 24. Have any accountable documents been lost? | | | |
| 25. Did drilling and well construction follow procedures outlined in the sampling plan? | | | |
| 26. Were the activities being conducted compatible with the environmental conditions? | | | |

Copies of the previous day's field notebook entries were collected at the health and safety meeting held each morning. This enabled on-going QA to be performed on all field notebooks without actually taking possession of the document and interfering with field activities. Field notebooks were also cross checked with the geologic logs to assure proper descriptions and footages. These approved geologic logs are then signed by the proper authority. All of the geologic logs are provided in Appendix D.

## 1.3 Laboratory Quality Assurance

Laboratory QA/QC sample results are provided as part of the analytical data (see Appendix E).

## 1.4 Deviations

A discussion of each deviation from the Remedial Investigation Plan is presented below.

1) The borehole sampling technique was modified. A discussion of the technique used can be located on pages C-6 and C-7 of Appendix C.

2) Field screening techniques were also modified. A discussion of the technique used can be located on page C-6 of Appendix C.

3) Completion of Well 5-87BR was modified to better define the vertical extent of contamination in the weathered bedrock. A better description can be found on pages C-4 and C-5 of Appendix C.

4) Completion of Well 8-87 was in a three-foot thick, water-bearing lignite bed. A discussion of this completion can be found on pages C-5 and C-6 of Appendix C.

5) Soil Gas Method: The two principle methods employed to sample soil gas are real time and time integrated.

   Real time measurements are extracted by inserting a hollow conduit into the soil to a given depth and evacuating a predesignated volume of gas. After the system has been purged of any atmospheric air, a sample is extracted and analyzed, either on-site or in a remote laboratory. The advantages of this procedure are that the data are, in general, available more quickly than time integrated methods. The disadvantages are the added equipment required to do the sampling and analysis and reducing

the mobility of the sampling vehicle. In addition, real time methods increase the lower detection limit.

Time integrated methods employ activated adsorbants to collect the contaminants for a period of time specifically determined for the site to concentrate the contaminant to a level that might otherwise be undetectable. Rather than mass per unit volume measurements that are the result of real time gas chromatographic analysis, time integrated results are measured in terms of molecular counts. Both methods can only be used as a reconnaissance tool as they merely give a qualitative notion of subsurface concentrations. Time integration also alleviates any variations in the contaminant concentrations due to transient situations that might not reflect the true conditions. In addition, all equipment required to perform the sampling can be carried into the target area by two individuals, thus reducing traffic in areas where heavy traffic might permit re-suspension of soil possibly contaminated with radioactive contaminants.

Considerations of increased mobility, lower detection limits, and reduction of heavy traffic on grasslands influenced our decision to re-evaluate the method to be used and substitute Petrex's time integrated method.

Grid Spacing: The grid spacing for the soil gas stations was determined to be inconsistent with Petrex's recommended alignment. In areas of suspected plume migration, Petrex urges the employment of a random or offset grid opposed to an orthogonal grid. An offset grid is designed so that adjacent grid lines are sampled at non-aligned stations, thus disrupting the orthogonal pattern of the uniform grid.

## 1.5 SOIL GAS QA

Duplicate and field blank Quality Assurance (QA) samples were taken during the soil gas sampling operation. Duplicate samples were taken by placing two wires into the same tube. Results of both wires are presented in Table F-2. Any contaminants, if found, are also shown. Field blanks were taken by installing sealed tubes next to an open tube. The field blank results are also presented in Table F-2.

## TABLE F-2

## SOIL GAS QUALITY ASSURANCE

| SAMPLE LOCATION | DUPLICATE | BLANK |
|---|---|---|
| 14 | ----- | 0 |
| 17 | ----- | 0 |
| 32 | 0:0 | ----- |
| 50 | PCE 965:209 | ----- |
| 65 | 0:0 | ----- |
| 93 | 0:0 | ----- |
| 98 | 0:0 | ----- |
| 101 | 0:0 | ----- |
| 104 | 0:0 | ----- |
| 107 | 0:0 | ----- |
| 110 | PCE 155:455 PCE | ----- |
| 114 | 0:0 | ----- |
| 115 | PCE 1,006:0 | ----- |
| 116 | PCE 968:1,271<br>0:352 TCE | ----- |

# APPENDIX F-1

# DETAILED AUDIT FORMS

# WELL INSTALLATION AUDIT

Well Number: 1-87

Date: 5/8/87

Audit Performed by: B. R. Lewis

Geologist's name: Suzanne Pascke

How far into bedrock does the borehole extend? 3'

What was used to backfill any excess depth? Bentonite

How long was the bentonite allowed to swell? N/A

Was water added? N/A How much? N/A

How long was it allowed to swell or set? N/A

What was the source of water? N/A

If grout was used how long was it allowed to set? N/A

Was the borehole remeasured to determine the new depth? Yes

Was the well design approved by the site manager? Yes

Is the completion depth greater than one foot into bedrock? No

Does the screened alluvial interval extend two to five feet above the water table? See comments in problems section

Is the screened bedrock interval in a saturated sandstone? N/A

Is it at least five feet long? N/A

Does the sand pack design extend no more than two feet above the screen? Yes

Is 10-slot screen being used? Yes

Is 32-42 sand being used? Yes

Was the casing string (cap included) measured to the nearest 1/100th ft. before being placed into the borehole? Yes

When was the well construction material decontaminated? Yes

How was it decontaminated? Steam cleaned, alconox wash, DI rinse

Is care taken to keep this material clean? Yes

Once the casing is in the borehole, was the amount of stick up determined? Yes

**Does the casing's position agree with the well design?** Yes

**Were total volumes of construction material calculated?** Yes

**Is care taken to prevent materials from bridging?** Yes

**Is the filter pack evenly distributed by shaking the casing?** Yes

**Are frequent depth measurements taken to assure the location of pack material?** Yes

**Is the bentonite seal greater than one foot?** 1.0 F+ from 3' - 2' below surface

**Was water added to the bentonite?** Yes

**How much?** 1.0 gal **How long was it allowed to swell?** 5 min for top seal 10 min for bottom seal

**What was the source of water?** N/A

**Were the total volume of construction material used recorded?** Yes

**Were the internal depths recorded?** Yes

**Was the well construction summary sheet adequately filled out?** Only in log book

**Is the grout mixture 6 to 9 gallons of water per 94-lb bag of Type I or II Portland cement?** Yes

**Was the grout pumped or poured?** Poured

**Was stick-up remeasured once well was completed?** Yes

**Does the protective casing have an identification number?** No

**Is there a seven inch clearance between the inner casing and the locking device?** Yes, too much clearance

**Note any problems encountered:** During drilling the Qrf seemed damp, but the highly weathered bedrock was more moist. Another well maybe put in here at a later date to see if ground water could be flowing thru the weathered bedrock. No static water level was found.

# WELL INSTALLATION AUDIT

Well Number: 2-87 (BH3)

Date: 5/20/87

Audit Performed by: C. Sundblad

Geologist's name: Karen Holliway

When was the well construction material decontaminated? Yes

How was it decontaminated? Alconox wash, steam rinse

Is care taken to keep this material clean? Yes - on racks

How far into bedrock does the borehole extend? 16' TD

What was used to backfill any excess depth? Bentonite

If grout was used how long was it allowed to set? N/A

Was the borehole remeasured to determine the new depth? Yes

Was the well design approved by the site manager? Yes

It the completion depth greater than one foot into bedrock? Yes, Contact = 8.5'

Does the screened interval extend two to five feet above the water table? Yes

Does the sand pack design extend no more than two feet above the screen? Yes 2'

Is 10-slot screen being used? Yes

Is 32-42 sand being used? Yes

Was the casing string (cap included) measured to the nearest 1/100th ft. before being placed into the borehole? Yes

Once the casing is in the borehole, was the amount of stick up determined? Yes

Does the casing's position agree with the well design? Yes

Were total volumes of construction material calculated? Yes

Is care taken to prevent materials from bridging? Yes- slowly added sand

Is the filter pack evenly distributed by shaking the casing? Yes

Does the casing's position agree with the well design? Within 0,22'

Were total volumes of construction material calculated? Yes

Is care taken to prevent materials from bridging? Yes, measurements taken

Is the filter pack evenly distributed by shaking the casing? Yes

Are frequent depth measurements taken to assure the location of pack material? Yes

Is the bentonite seal greater than one foot? No 0.5'

Was water added to the bentonite? Not recorded

How much? N/A How long was it allowed to swell? N/A

What was the source of water? N/A

Were the total volume of construction material used recorded? Yes

Were the internal depths recorded? Yes

Was the well construction summary sheet adequately filled out? Log books

Is the grout mixture 6 to 9 gallons of water per 94-lb bag of Type I or II Portland cement? Yes

Was the grout pumped or poured? Poured

Was stick-up remeasured once well was completed? Yes

Does the protective casing have an identification number? Not recorded

Is there a seven inch clearance between the inner casing and the locking device? Not recorded

Note any problems encountered:

# DRILLING AUDIT

Well Number: 2-87 (BH-3)

Date: 5/19/87, 5/20/87

Audit Performed by: C. Sundblad

Geologist's name? Karen Holliway

Date drilling started? 5/19/87

Type of drill rig being used? Mobile B-57

Proposed formation of completion? Rocky Flats Alluvium

Type of sampling device being used? Split core barrel, hollow auger

What type of recovery is being obtained? 75%

Were augers and sampling devices decontaminated? Yes

Are they kept clean? Yes

If an alluvial well, did they drill one to three feet into bedrock? Yes

Was any fluid used while drilling? No

If a bedrock well, was the surface casing set into unweathered bedrock? N/A

What type of grout was used to set the casing? N/A

Was the mixture 6 to 9 gallons of water per 94 lbs. of grout? N/A

Was the grout allowed to set for 24 hours? N/A

What size is the core? 2" (xix, xlc)

Were at least three feet of saturated sandstone found in a ten foot interval of bedrock or was 100' of claystone encountered? N/A

Explain reasons for choosing the total depth if it is different?

Was a packer test conducted? No

Note any drilling problems:

## BOREHOLE LOGGING

Well Number: 2-87 (BH-3)

Date: 5/19/87

Audit Performed by: C. Sundblad

Geologist's name: Karen Holliway

The field notebook and log of borings from should be filled out in detail. The following items should be found in both.

Borehole number? BH-3

Time/date? Yes

Footage? Yes

Recent Recovery? Yes

Material type? Colluvium

Color? Yes

Structural characteristics? Contact

Grain sizes? Descriptive

Degree of sorting? None recorded

Grain shapes? None recorded

Moisture content? Descriptive

Nature of contacts? Alluvium/weathered B.R.

Organic and radioactive field screening results? Yes

Are the cores wrapped in plastic and placed in boxes? Yes

Are the intervals properly identified? Yes

Are the boxes properly identified? Yes

Is the driller keeping a daily log detailing footage drilled, material used, and stand-by time? Yes

Is the geologist (Field Team Leader) doing the same? Yes

## FIELD SCREENING & SAMPLING

2-87/BH3-87

Is 50 to 100 ml of soil being placed in 500 ml amber glass jars with equal amounts of deionized water? No - clear glass jars were used (see Appendix C)

Is the jar capped, shaken and allowed to stand for 30 minutes? Yes

Is each jar labeled with date, time, borehole number, interval? Yes

Are the screening instruments calibrated to a specific compound? Yes

Are all readings recorded in the field notebook and the log of the borings?
Yes

Are designated samples placed in labeled jars and then place on ice in a cooler?
Yes

Is the chain of custody form properly filled out? Yes

# WELL INSTALLATION AUDIT

Well Number: 3-87 (BR)
Date: 6/14/87
Audit Performed by: C. Sundblad

Geologist's name: J. Bergman

How far into bedrock does the borehole extend? 117.'0

What was used to backfill any excess depth? 3/8" Bentonite pellets

How long was the bentonite allowed to swell? Overnight

Was water added? No How much? N/A

How long was it allowed to swell or set? Overnight

What was the source of water? rig (raw water from plantsite)

If grout was used how long was it allowed to set? N/A

Was the borehole remeasured to determine the new depth? Yes - 108'

Was the well design approved by the site manager? Yes

Is the completion depth greater than one foot into bedrock? N/A

Does the screened alluvial interval extend two to five feet above the water table? N/A

Is the screened bedrock interval in a saturated sandstone? Yes (Wet)

Is it at least five feet long? Yes - 6'

Does the sand pack design extend no more than two feet above the screen? 0.5'

Is 10-slot screen being used? Yes

Is 32-42 sand being used? Yes

Was the casing string (cap included) measured to the nearest 1/100th ft. before being placed into the borehole? Yes

When was the well construction material decontaminated? Prior to installation

How was it decontaminated? Alconox and rinse

Is care taken to keep this material clean? on racks, off ground

Once the casing is in the borehole, was the amount of stick up determined? Yes

Does the casing's position agree with the well design? Yes

Were total volumes of construction material calculated? Yes

Is care taken to prevent materials from bridging? Yes

Is the filter pack evenly distributed by shaking the casing? Yes

Are frequent depth measurements taken to assure the location of pack material? Yes

Is the bentonite seal greater than one foot? 3'

Was water added to the bentonite? Not noted

How much? N/A How long was it allowed to swell? N/A

What was the source of water? N/A

Were the total volume of construction material used recorded? Yes

Were the internal depths recorded? Yes

Was the well construction summary sheet adequately filled out? Yes

Is the grout mixture 6 to 9 gallons of water per 94-lb bag of Type I or II Portland cement? 7:1 Type I

Was the grout pumped or poured? Poured

Was stick-up remeasured once well was completed? Yes

Does the protective casing have an identification number? _____

Is there a seven inch clearance between the inner casing and the locking device? Yes

Note any problems encountered: _____

# PACKER TEST AUDIT

Well Number: 3-87BR

Date: 6/2/87

Audit performed by: C. L. Sundblad

Geologist's name: Janell Bergman

Date drill was completed: 6/2/87

Was packer test equipment decontaminated? Yes

When? _____

Was it kept clean? _____

Any problems with caving? _____

Were the packers inflated to at least 70 ps: above hydrostatic pressure? 80 psi

psi reading? 80 psi Hydrostatic reading? 42.32

Was the overburden pressure calculated? Yes Estimate was 42.08 psi

What was the water source? rig - raw water from plantsite

Was the combined static plus gauge pressure approximately:

one-third of the overburden pressure for the first test? X Reading 47.40

two-thirds of the overburden pressure for the second test? X Reading 43.89

one-third of the overburden pressure for the third test? X Reading

Were any leaks observed? Yes - packer assembly adjusted/test unvalid

Was the flow rate record in gpm at equal time intervals? Yes

What were the time intervals? 1 min

How long did each test last? 1. 15 min
2. 15 min
3. 15 min

Was the borehole reamed to a minimum four inch diameter for well installation? No

# DRILLING AUDIT

Well Number: 3-87BR

Date: 5/15/87, 6/1/87, 6/2/87

Audit Performed by: C. Sundblad

Geologist's name? Karen Holliway; Janell Bergman

Date drilling started? 5/15/87

Type of drill rig being used? Mobile B-57

Proposed formation of completion? Arapahoe ss or water bearing member

Type of sampling device being used? Split core barrel

What type of recovery is being obtained? 90 - 100%

Were augers and sampling devices decontaminated? Yes

Are they kept clean? Yes

If an alluvial well, did they drill one to three feet into bedrock? N/A

Was any fluid used while drilling? No

If a bedrock well, was the surface casing set into unweathered bedrock? Yes

What type of grout was used to set the casing? Portland

Was the mixture 6 to 9 gallons of water per 94 lbs. of grout? Yes

Was the grout allowed to set for 24 hours? Yes

What size is the core? 2"

Were at least three feet of saturated sandstone found in a ten foot interval of bedrock or was 100' of claystone encountered? Yes

Explain reasons for choosing the total depth if it is different? N/A

Was a packer test conducted? Yes

Note any drilling problems:

# BOREHOLE LOGGING

Well Number: 3-87BR

Date: 5/15/87

Audit Performed by: C. L. Sundblad

Geologist's name: Karen Holliway

The field notebook and log of borings from should be filled out in detail. The following items should be found in both.

Borehole number? 3-87BR

Time/date? Yes

Footage? Yes

Recent Recovery? Yes

Material type? Yes

Color? Yes

Structural characteristics? Contacts noted

Grain sizes? Descriptive

Degree of sorting? Poor to well sorted noted

Grain shapes? Yes

Moisture content? Descriptive only

Nature of contacts? Alluvium/weathered BR/unweathered BR

Organic and radioactive field screening results? Yes

Are the cores wrapped in plastic and placed in boxes? Yes

Are the intervals properly identified? Yes

Are the boxes properly identified? Yes

Is the driller keeping a daily log detailing footage drilled, material used, and stand-by time? Yes

Is the geologist (Field Team Leader) doing the same? Yes

# WELL INSTALLATION AUDIT

Well Number: 4-87

Date: 5-12-87

Audit Performed by: Brent Lewis

Geologist's name: Karen Holliway

How far into bedrock does the borehole extend? 23.4=TD 21.91=TD after sluff

What was used to backfill any excess depth? stuffed some to 21'

How long was the bentonite allowed to swell? _____

Was water added? None How much? water table is high

How long was it allowed to swell or set? 15 - 20 min.

What was the source of water? 664 fire hydrant

If grout was used how long was it allowed to set? _____

Was the borehole remeasured to determine the new depth? Yes

Was the well design approved by the site manager? Yes

Is the completion depth greater than one foot into bedrock? No

Does the screened alluvial interval extend two to five feet above the water table? Due to high WT season, 1.5' screen above WT is sufficient

Is the screened bedrock interval in a saturated sandstone? N/A

Is it at least five feet long? N/A

Does the sand pack design extend no more than two feet above the screen? Yes

Is 10-slot screen being used? Yes

Is 32-42 sand being used? Yes

Was the casing string (cap included) measured to the nearest 1/100th ft. before being placed into the borehole? Yes

When was the well construction material decontaminated? Prior to installation

How was it decontaminated? Steam clean, Alconox scrub & steam clean

Is care taken to keep this material clean? Yes

Once the casing is in the borehole, was the amount of stick up determined? Yes

Does the casing's position agree with the well design? Yes

Were total volumes of construction material calculated? Yes

Is care taken to prevent materials from bridging? Yes

Is the filter pack evenly distributed by shaking the casing? Yes

Are frequent depth measurements taken to assure the location of pack material? Yes

Is the bentonite seal greater than one foot? 1.1'

Was water added to the bentonite? Yes

How much? 1¼ gal How long was it allowed to swell? 10 min

What was the source of water? 664

Were the total volume of construction material used recorded? Yes

Were the internal depths recorded? Yes

Was the well construction summary sheet adequately filled out? None used

Is the grout mixture 6 to 9 gallons of water per 94-lb bag of Type I or II Portland cement? 6 gal/2 bags - 47 lbs/bag

Was the grout pumped or poured? Poured

Was stick-up remeasured once well was completed?

Does the protective casing have an identification number? ID# done later when pad is poured

Is there a seven inch clearance between the inner casing and the locking device?

Note any problems encountered: Driller (Alan) has grease on tyvex. He is careful with gloves, changed gloves but not tyvek. Was asked to change tyvek. Decontamination of stainless steel casing occurred again after the casing string was pulled, to wash off the bentonite mud.

# DRILLING AUDIT

Well Number: 5-87 BR

Date: 6/23/87

Audit Performed by: C. Sunblad

Geologist's name? Michael Gard/Janell Bergman

Date drilling started? 5/21/87

Type of drill rig being used? Mobile B-57

Proposed formation of completion? Bedrock - Arapahoe water bearing member

Type of sampling device being used? Splitcore barrel

What type of recovery is being obtained? ~ 90%

Were augers and sampling devices decontaminated? Yes

Are they kept clean? On racks

If an alluvial well, did they drill one to three feet into bedrock? NA

Was any fluid used while drilling? No

If a bedrock well, was the surface casing set into unweathered bedrock? No

What type of grout was used to set the casing? Portland Type I

Was the mixture 6 to 9 gallons of water per 94 lbs. of grout? Yes

Was the grout allowed to set for 24 hours? Yes

What size is the core? 2"

Were at least three feet of saturated sandstone found in a ten foot interval of bedrock or was 100' of claystone encountered?

Explain reasons for choosing the total depth if it is different? This well was completed in weathered bedrock to monitor the upper flow zone.

Was a packer test conducted? Yes

Note any drilling problems: Please note that no samples for field screening were taken,

# BOREHOLE LOGGING

**Well Number:** 5-87 BR

**Date:** 6/23/87

**Audit Performed by:** C. Sunblad

**Geologist's name:** Michael Gard/Janell Bergman

**The field notebook and log of borings from should be filled out in detail. The following items should be found in both.**

**Borehole number?** Yes

**Time/date?** Yes

**Footage?** Yes

**Recent Recovery?** Yes

**Material type?** Yes

**Color?** Yes

**Structural characteristics?** Fractures, mottles

**Grain sizes?** Descriptive

**Degree of sorting?** Yes

**Grain shapes?** Fine to very fine grained sands

**Moisture content?** Descriptive

**Nature of contacts?** Alluvium/bedrock

**Organic and radioactive field screening results?** Yes

**Are the cores wrapped in plastic and placed in boxes?** Yes

**Are the intervals properly identified?** Yes

**Are the boxes properly identified?** Yes

**Is the driller keeping a daily log detailing footage drilled, material used, and stand-by time?** Yes

**Is the geologist (Field Team Leader) doing the same?** Yes

## FIELD SCREENING & SAMPLING

5-87BR

Is 50 to 100 ml of soil being placed in 500 ml amber glass jars with equal amounts of deionized water? See note on drilling audit note

Is the jar capped, shaken and allowed to stand for 30 minutes? _____

Is each jar labeled with date, time, borehole number, interval? _____

Are the screening instruments calibrated to a specific compound? _____

Are all readings recorded in the field notebook and the log of the borings?

_____

Are designated samples placed in labeled jars and then place on ice in a cooler?

_____

Is the chain of custody form properly filled out? _____

# PACKER TEST AUDIT

Well Number: 5-87 BR

Date: 5/28/87

Audit performed by: C. Sunblad

Geologist's name: Janell Bergman

Date drill was completed: 5/27/87

Was packer test equipment decontaminated? Not noted in Field Book

When? _____

Was it kept clean? Yes - on racks

Any problems with caving? None noted

Were the packers inflated to at least 70 ps: above hydrostatic pressure? Yes

psi reading? 80 psi Hydrostatic reading? 19.69 psi

Was the overburden pressure calculated? Yes Estimate was 19.69 psi

What was the water source? Rig - rawwater from plantsite

Was the combined static plus gauge pressure approximately:

one-third of the overburden pressure for the first test? X Reading 15.26 psi

two-thirds of the overburden pressure for the second test? X Reading 30.52 psi

one-third of the overburden pressure for the third test? X Reading

Were any leaks observed? Yes, several tests aborted due to waterloss

Was the flow rate record in gpm at equal time intervals? Yes/Watercolumn

What were the time intervals? 1 minute

How long did each test last?

1. 15 minutes
2. 15 minutes
3. 15 minutes

Was the borehole reamed to a minimum four inch diameter for well installation? Yes

# WELL INSTALLATION AUDIT

Well Number: 5-87 BR

Date: 5/29/87

Audit Performed by: C. Sunblad

Geologist's name: Janell Bergman

When was the well construction material decontaminated? Yes

How was it decontaminated? Alconox wash, steam rinse

Is care taken to keep this material clean? Yes

How far into bedrock does the borehole extend? 61.7' T.D

What was used to backfill any excess depth? Yes 4.5'

If grout was used how long was it allowed to set? NA

Was the borehole remeasured to determine the new depth? Yes

Was the well design approved by the site manager? Yes

It the completion depth greater than one foot into bedrock? Yes

Does the screened interval extend two to five feet above the water table? NA

Does the sand pack design extend no more than two feet above the screen? Yes

Is 10-slot screen being used? Yes

Is 32-42 sand being used? Yes

Was the casing string (cap included) measured to the nearest 1/100th ft. before being placed into the borehole? Yes

Once the casing is in the borehole, was the amount of stick up determined? Yes

Does the casing's position agree with the well design? Yes

Were total volumes of construction material calculated? Yes

Is care taken to prevent materials from bridging? Yes

Is the filter pack evenly distributed by shaking the casing? Yes

Are frequent depth measurements taken to assure the location of pack material? Yes

Is the bentonite seal grater than one foot? Yes

Was the volume used recorded? Yes

Were the depths recorded? Yes

Was water added to the bentonite? No - not recorded

How much? _____ How long was it allowed to swell? _____

What was the source of water? NA

Was the well construction summary sheet adequately filled out? Yes

Is the grout mixture 6 to 9 gallons of water per 94-lb bag of Type I or II Portland cement? Yes

Was the grout pumped or poured? Pumped

Was stick-up remeasured once well was completed? Yes

Does the protective casing have an identification number? Yes

Is there a seven inch clearance between the inner casing and the locking device? Yes

Note any problems encountered: _____

# DRILLING AUDIT

Well Number: 6-87

Date: 5/14/87

Audit Performed by: C. Sundblad

Geologist's name? Karen Holliway

Date drilling started? 5/14/87

Type of drill rig being used? Mobile B-57

Proposed formation of completion? Alluvium

Type of sampling device being used? Split core barrel, hollow stem auger

What type of recovery is being obtained? 95%

Were augers and sampling devices decontaminated? Yes

Are they kept clean? Yes, Off ground

If an alluvial well, did they drill one to three feet into bedrock? Yes

Was any fluid used while drilling? No

If a bedrock well, was the surface casing set into unweathered bedrock? N/A

What type of grout was used to set the casing? Portland Type I

Was the mixture 6 to 9 gallons of water per 94 lbs. of grout? Yes

Was the grout allowed to set for 24 hours? Yes

What size is the core? 2"

Were at least three feet of saturated sandstone found in a ten foot interval of bedrock or was 100' of claystone encountered? N/A

Explain reasons for choosing the total depth if it is different? N/A

Was a packer test conducted? No

Note any drilling problems:

## BOREHOLE LOGGING

Well Number: 6-87

Date: 5/14/87

Audit Performed by: C. Sundblad

Geologist's name: Karen Holliway

The field notebook and log of borings from should be filled out in detail. The following items should be found in both.

Borehole number? 6-87

Time/date? Yes

Footage? Yes

Recent Recovery? Yes

Material type? Yes

Color? Yes

Structural characteristics? Some disturbed at 2'

Grain sizes? Yes

Degree of sorting? No comments on sorting

Grain shapes? No comments on shapes of grains

Moisture content? Yes, damp to moist

Nature of contacts? Alluvium/bedrock

Organic and radioactive field screening results? Yes - Logged

Are the cores wrapped in plastic and placed in boxes? Yes

Are the intervals properly identified? Yes

Are the boxes properly identified? Yes

Is the driller keeping a daily log detailing footage drilled, material used, and stand-by time? Yes

Is the geologist (Field Team Leader) doing the same? Yes

## FIELD SCREENING & SAMPLING

6-87

Is 50 to 100 ml of soil being placed in 500 ml amber glass jars with equal amounts of deionized water? None taken

Is the jar capped, shaken and allowed to stand for 30 minutes? N/A

Is each jar labeled with date, time, borehole number, interval? N/A

Are the screening instruments calibrated to a specific compound? Yes

Are all readings recorded in the field notebook and the log of the borings? Yes

Are designated samples placed in labeled jars and then place on ice in a cooler? N/A

Is the chain of custody form properly filled out? N/A

# WELL INSTALLATION AUDIT

Well Number: 6-87 (6-87A was abandoned)

Date: 5/14/87

Audit Performed by: C. Sundblad

Geologist's name: Karen Holliway

How far into bedrock does the borehole extend? 15½' (BH) Well TD = 7'

What was used to backfill any excess depth? Bentonite ( 3 3/4 buckets)

How long was the bentonite allowed to swell? 20 minutes

Was water added? Yes How much? 7 gal

How long was it allowed to swell or set? _____

What was the source of water? Drill rig tank filled on plantsite at fire hydrant

If grout was used how long was it allowed to set? _____

Was the borehole remeasured to determine the new depth? Yes

Was the well design approved by the site manager? Yes

Is the completion depth greater than one foot into bedrock? No (X 1/2')

Does the screened alluvial interval extend two to five feet above the water table? Yes

Is the screened bedrock interval in a saturated sandstone? N/A

Is it at least five feet long? N/A

Does the sand pack design extend no more than two feet above the screen? Yes

Is 10-slot screen being used? Yes

Is 32-42 sand being used? Yes

Was the casing string (cap included) measured to the nearest 1/100th ft. before being placed into the borehole? Yes

When was the well construction material decontaminated? Prior to installation

How was it decontaminated? Steam clean and Alconox (detergent)

Is care taken to keep this material clean? Yes - off ground

Once the casing is in the borehole, was the amount of stick up determined? Yes

Does the casing's position agree with the well design? Yes

Were total volumes of construction material calculated? Bentonite + H20 Yes

Is care taken to prevent materials from bridging? Yes

Is the filter pack evenly distributed by shaking the casing? Yes

Are frequent depth measurements taken to assure the location of pack material? Yes

Is the bentonite seal greater than one foot? Yes 13'

Was water added to the bentonite? Yes

How much? 1 gal How long was it allowed to swell? 20 min

What was the source of water? drill tank

Were the total volume of construction material used recorded? yes

Were the internal depths recorded?

Was the well construction summary sheet adequately filled out? N/A

Is the grout mixture 6 to 9 gallons of water per 94-lb bag of Type I or II Portland cement? 6 gal to 94 lb = good cement/used 1 bqg + 3 gal H20

Was the grout pumped or poured? Poured

Was stick-up remeasured once well was completed? Yes

Does the protective casing have an identification number?

Is there a seven inch clearance between the inner casing and the locking device? Yes

Note any problems encountered: Oil leak from bearings on soil around borehole.

Kept drill cuttings shoveled away from borehole. Covered ss casing with plastic sheet to prevent contamination as rig was moved away from borehole.

# DRILLING AUDIT

Well Number: 6-87A

Date: 5/13/87

Audit Performed by: C. Sundblad

Geologist's name? Karen Holliway

Date drilling started? 5/13/87

Type of drill rig being used? Mobile B-57

Proposed formation of completion? Alluvium

Type of sampling device being used? Split core barrel, hollow stem auger

What type of recovery is being obtained? 20%, Consol. 80% Consol. 100%

Were augers and sampling devices decontaminated? Sampler decontaminated with alconox prior to resampling;scrubbed couplings tube

Are they kept clean? Off ground

If an alluvial well, did they drill one to three feet into bedrock? Yes

Was any fluid used while drilling? No

If a bedrock well, was the surface casing set into unweathered bedrock? N/A

What type of grout was used to set the casing? Portland Type I

Was the mixture 6 to 9 gallons of water per 94 lbs. of grout? Yes

Was the grout allowed to set for 24 hours? Plugged and abandoned

What size is the core? 2"

Were at least three feet of saturated sandstone found in a ten foot interval of bedrock or was 100' of claystone encountered? N/A

Explain reasons for choosing the total depth if it is different? Seeking wet or damp interval indicative of ground water flow.

Was a packer test conducted? N/A

Note any drilling problems: Vertical deviation - how determined? 7½" hole auger drilled; 3¼" hollow stem; 2" core

# BOREHOLE LOGGING

Well Number: 6-87A

Date: 5/13/87

Audit Performed by: C. Sundblad

Geologist's name: Karen Holliway

The field notebook and log of borings from should be filled out in detail. The following items should be found in both.

Borehole number? 6-87 A

Time/date? AM 5/13/87

Footage? TD = 32 ft.

Recent Recovery? 78%

Material type? alluvium, claystone, sandstone

Color? Yellow orange, brown weathered claystones & sandstones

Structural characteristics? Same disturbed laminations

Grain sizes? clays, sands, cobbles

Degree of sorting? Poorly sorted sandy claystones to coarse sand-well sorted

Grain shapes? Subrounded

Moisture content? dry

Nature of contacts? alluvium/weathered bedrock

Organic and radioactive field screening results? HNU @ background, alphas @ 0.0

Are the cores wrapped in plastic and placed in boxes? Yes

Are the intervals properly identified? Yes

Are the boxes properly identified? Yes

Is the driller keeping a daily log detailing footage drilled, material used, and stand-by time? Yes

Is the geologist (Field Team Leader) doing the same? Yes

## FIELD SCREENING & SAMPLING

6-87A

Is 50 to 100 ml of soil being placed in 500 ml amber glass jars with equal amounts of deionized water? None taken

Is the jar capped, shaken and allowed to stand for 30 minutes? N/A

Is each jar labeled with date, time, borehole number, interval? N/A

Are the screening instruments calibrated to a specific compound? Yes

Are all readings recorded in the field notebook and the log of the borings? Yes

Are designated samples placed in labeled jars and then place on ice in a cooler? N/A

Is the chain of custody form properly filled out? _____

# DRILLING AUDIT

**Well Number:** 7-87 BRA

**Date:** 6/4/76 - 6/8/87

**Audit Performed by:** C. L. Sundblad

**Geologist's name?** Karen D. Holliway/Janell Bergman

**Date drilling started?** 6/4/87

**Type of drill rig being used?** Mobile B-57

**Proposed formation of completion?** Arapahoe - below alluvium and above 5-87 zone of completion

**Type of sampling device being used?** Hollow stem auger/core barrel

**What type of recovery is being obtained?** Variable, some lost core zones; 75% to 100%

**Were augers and sampling devices decontaminated?** Yes

**Are they kept clean?** Yes - on racks

**If an alluvial well, did they drill one to three feet into bedrock?** N/A

**Was any fluid used while drilling?** No, on 0-35' Yes, with rig change to TD

**If a bedrock well, was the surface casing set into unweathered bedrock?** N/A (not set)

**What type of grout was used to set the casing?** N/A

**Was the mixture 6 to 9 gallons of water per 94 lbs. of grout?** N/A

**Was the grout allowed to set for 24 hours?** N/A

**What size is the core?** 2"

**Were at least three feet of saturated sandstone found in a ten foot interval of bedrock or was 100' of claystone encountered?** No - not in target interval

**Explain reasons for choosing the total depth if it is different?** (goal was to construct well between alluvium and fractured zone (5-87 BR). Abandoned because no moisture of flow was intercepted.

**Was a packer test conducted?** No

**Note any drilling problems:** Core barrel stuck in augers; broken wireline. Please note that no field screening was performed because no sampling was planned for this well. The Health and Safety organic and radioactive screening was performed during drilling, as required.

# BOREHOLE LOGGING

**Well Number:** 7-87 BRA

**Date:** 6/22/87

**Audit Performed by:** C. Sundblad

**Geologist's name:** Karen Holliway/Janell Bergman

**The field notebook and log of borings from should be filled out in detail. The following items should be found in both.**

**Borehole number?** 7-87 BR; 7-87 BRA (cemented and abandoned)

**Time/date?** Yes

**Footage?** Yes

**Recent Recovery?** Yes

**Material type?** Yes - Descriptions

**Color?** Yes - Weathered/Unweathered

**Structural characteristics?** Some

**Grain sizes?** Yes - descriptive

**Degree of sorting?** Some description

**Grain shapes?** Yes

**Moisture content?** Descriptive

**Nature of contacts?** Alluvium/weathered bedrock/no log of unweathered contact

**Organic and radioactive field screening results?** Yes

**Are the cores wrapped in plastic and placed in boxes?** Yes

**Are the intervals properly identified?** Yes

**Are the boxes properly identified?** Yes

**Is the driller keeping a daily log detailing footage drilled, material used, and stand-by time?** Yes

**Is the geologist (Field Team Leader) doing the same?** Yes

FIELD SCREENING & SAMPLING
7-87BRA

Is 50 to 100 ml of soil being placed in 500 ml amber glass jars with equal amounts of deionized water? See note on drilling audit note area.

Is the jar capped, shaken and allowed to stand for 30 minutes? _____

Is each jar labeled with date, time, borehole number, interval? _____

Are the screening instruments calibrated to a specific compound? _____

Are all readings recorded in the field notebook and the log of the borings?

_____

Are designated samples placed in labeled jars and then place on ice in a cooler?

_____

Is the chain of custody form properly filled out? _____

# DRILLING AUDIT

Well Number: 8-87BR

Date: 5/14 - 5/15/87

Audit Performed by: C. Sundbland

Geologist's name? Janell Bergman

Date drilling started? 5/13/87

Type of drill rig being used? Failing rotary

Proposed formation of completion? Bedrock Arapahoe SS

Type of sampling device being used? NX core barrel

What type of recovery is being obtained? 75-100% 4' core rounds

Were augers and sampling devices decontaminated? Yes

Are they kept clean? Yes/off ground

If an alluvial well, did they drill one to three feet into bedrock? N/A

Was any fluid used while drilling? yes, water

If a bedrock well, was the surface casing set into unweathered bedrock? 40' (slightly weathered 43-46')

What type of grout was used to set the casing? Portland Type I (redrilled)

Was the mixture 6 to 9 gallons of water per 94 lbs. of grout? Yes

Was the grout allowed to set for 24 hours? Yes

What size is the core? 2" NX NDX (XXX, XXX)

Were at least three feet of saturated sandstone found in a ten foot interval of bedrock or was 100' of claystone encountered? 3½' of lignite-wet interstitially

Explain reasons for choosing the total depth if it is different? N/A

Was a packer test conducted? Yes

Note any drilling problems: Sluff/bridge on packer test installation-reamed hole Geologist noted "water coming up outside the casing; bubbling up in the gd and the 2 adjacent wells". Needs to be clarified.

## BOREHOLE LOGGING

**Well Number:** 8-87BR

**Date:** 5/20/87

**Audit Performed by:** C. Sundblad

**Geologist's name:** Janell Bergman

**The field notebook and log of borings from should be filled out in detail. The following items should be found in both.**

**Borehole number?** 8-87BR Fieldbook

**Time/date?** Fieldbook

**Footage?** Fieldbook

**Recent Recovery?** Fieldbook

**Material type?** Fieldbook

**Color?** Fieldbook

**Structural characteristics?** Fieldbook

**Grain sizes?** Fieldbook

**Degree of sorting?**

**Grain shapes?** Fieldbook

**Moisture content?** Fieldbook (Descriptive)

**Nature of contacts?** Fieldbook

**Organic and radioactive field screening results?** Fieldbook

**Are the cores wrapped in plastic and placed in boxes?** Yes

**Are the intervals properly identified?** Yes

**Are the boxes properly identified?** Yes

**Is the driller keeping a daily log detailing footage drilled, material used, and stand-by time?** Yes

**Is the geologist (Field Team Leader) doing the same?** Yes

# PACKER TEST AUDIT

Well Number: 8-87 BR

Date: 5/18/87

Audit performed by: Cindy Sunblad

Geologist's name: Janell Bergman

Date drill was completed: 5/15/87

Was packer test equipment decontaminated? Yes

When? Late afternoon prior to packer test on 5/18/87

Was it kept clean? Yes on racks

Any problems with caving? Yes bridge drilled out at 77'

Were the packers inflated to at least 70 ps: above hydrostatic pressure? Yes

psi reading? 80 psi Hydrostatic reading? 42.550

Was the overburden pressure calculated? Yes Estimate was 37.87 psi

What was the water source? Raw water from Plantsite in rig water tank

Was the combined static plus gauge pressure approximately:

one-third of the overburden pressure for the first test? X Reading 27.81 psi

two-thirds of the overburden pressure for the second test? X Reading 52.62 psi

one-third of the overburden pressure for the third test? X Reading

Were any leaks observed? No

Was the flow rate record in gpm at equal time intervals? Yes/water column

What were the time intervals? One minute

How long did each test last?

1. 15 minutes
2. 15 minutes
3. 15 minutes

Was the borehole reamed to a minimum four inch diameter for well installation? Yes

# PACKER TEST AUDIT

Well Number: 8-87BR

Date: 5/18/87

Audit performed by: C. Sundblad

Geologist's name: Janell Bergman

Date drill was completed: 5/15/87

Was packer test equipment decontaminated? Yes

When? 5/15/87 Friday P.M. (afternoon)

Was it kept clean? Yes off ground

Any problems with caving? 77' (bridge?), reamed

Were the packers inflated to at least 70 ps: above hydrostatic pressure? 80 psi

psi reading? 80 psi Hydrostatic reading? 83.43 ft

Was the overburden pressure calculated? Yes Estimate was 27.81

What was the water source? rig tank filled at Plant Site

Was the combined static plus gauge pressure approximately:

one-third of the overburden pressure for the first test? ____ Reading 0 psi

two-thirds of the overburden pressure for the second test? ___ Reading 17.56

one-third of the overburden pressure for the third test? ____ Reading

Were any leaks observed? No packer leaks or seal problems

Was the flow rate record in gpm at equal time intervals? Yes - 1 min/15 min

What were the time intervals? 1 min/15 min

How long did each test last? 1. 15 min Total tests

2. 15 min (3 good)

3. 15 min 12 15 min test

Was the borehole reamed to a minimum four inch diameter for well installation? No - 4" hole (OD coring bit = 4")

# WELL INSTALLATION AUDIT

Well Number: 8-87 BR

Date: 6/5/87

Audit Performed by: C. Sunblad

Geologist's name: Janell Bergman

When was the well construction material decontaminated? Prior to installation

How was it decontaminated? Alconox wash and steam rinse

Is care taken to keep this material clean? Yes - on rack

How far into bedrock does the borehole extend? 95.53 T.D.

What was used to backfill any excess depth? Yes ≈ 6' to 89.34'

If grout was used how long was it allowed to set? NA

Was the borehole remeasured to determine the new depth? Yes

Was the well design approved by the site manager? Yes

It the completion depth greater than one foot into bedrock? Yes

Does the screened interval extend two to five feet above the water table? NA

Does the sand pack design extend no more than two feet above the screen? Yes

Is 10-slot screen being used? Yes

Is 32-42 sand being used? Yes

Was the casing string (cap included) measured to the nearest 1/100th ft. before being placed into the borehole? Yes

Once the casing is in the borehole, was the amount of stick up determined? Yes

Does the casing's position agree with the well design? Yes

Were total volumes of construction material calculated? Yes

Is care taken to prevent materials from bridging? Yes

Is the filter pack evenly distributed by shaking the casing? Yes

Are frequent depth measurements taken to assure the location of pack material? Yes

Is the bentonite seal grater than one foot? Yes - 3 Ft.

Was the volume used recorded? Yes

Were the depths recorded? Yes

Was water added to the bentonite? Yes

How much? 1 Gal How long was it allowed to swell? Overnight

What was the source of water? Rig

Was the well construction summary sheet adequately filled out? Yes

Is the grout mixture 6 to 9 gallons of water per 94-lb bag of Type I or II Portland cement? Yes

Was the grout pumped or poured? Poured

Was stick-up remeasured once well was completed? Yes

Does the protective casing have an identification number? Yes

Is there a seven inch clearance between the inner casing and the locking device? Yes

Note any problems encountered:

# DRILLING AUDIT

Well Number: BH5-87

Date: 5/20/87

Audit Performed by: C. Sundblad

Geologist's name? M. Gard

Date drilling started? 5/19/87

Type of drill rig being used? Mobile B-57

Proposed formation of completion? No completion - soil boring

Type of sampling device being used? Split core barrel

What type of recovery is being obtained? 100%

Were augers and sampling devices decontaminated? Yes

Are they kept clean? Off ground - yes

If an alluvial well, did they drill one to three feet into bedrock? N/A

Was any fluid used while drilling? No

If a bedrock well, was the surface casing set into unweathered bedrock? N/A

What type of grout was used to set the casing? N/A

Was the mixture 6 to 9 gallons of water per 94 lbs. of grout? N/A

Was the grout allowed to set for 24 hours? N/A

What size is the core? 2"

Were at least three feet of saturated sandstone found in a ten foot interval of bedrock or was 100' of claystone encountered? N/A

Explain reasons for choosing the total depth if it is different? Soil boring - exploratory organics/radiometric

Was a packer test conducted? N/A

Note any drilling problems: No - backfill w/Portland Type I Concrete.

## BOREHOLE LOGGING

Well Number: BH5-87

Date: 5/20/87

Audit Performed by: C. Sundblad

Geologist's name: Mike Gard

The field notebook and log of borings from should be filled out in detail. The following items should be found in both.

Borehole number? Yes

Time/date? Yes

Footage? Yes

Recent Recovery? Yes

Material type? Yes

Color? Yes

Structural characteristics? N/A

Grain sizes? Descriptive

Degree of sorting? Not recorded

Grain shapes? Descriptive

Moisture content? Descriptive

Nature of contacts? Alluvium/bedrock recorded

Organic and radioactive field screening results? Not recorded

Are the cores wrapped in plastic and placed in boxes? Yes

Are the intervals properly identified? Yes

Are the boxes properly identified? Yes

Is the driller keeping a daily log detailing footage drilled, material used, and stand-by time? Yes - standby not noted

Is the geologist (Field Team Leader) doing the same? Yes

FIELD SCREENING & SAMPLING

BH 5-87

Is 50 to 100 ml of soil being placed in 500 ml amber glass jars with equal amounts of deionized water? Not

Is the jar capped, shaken and allowed to stand for 30 minutes? _____

Is each jar labeled with date, time, borehole number, interval? _____

Are the screening instruments calibrated to a specific compound? _____

Are all readings recorded in the field notebook and the log of the borings?

_____

Are designated samples placed in labeled jars and then place on ice in a cooler?

_____

Is the chain of custody form properly filled out? _____

# DRILLING AUDIT

Well Number: BH 6-87

Date: June 23, 1987

Audit Performed by: C. Sundblad

Geologist's name? Michael Gard

Date drilling started? 5/20/87

Type of drill rig being used? BH57

Proposed formation of completion? Alluvium - exploratory borehole

Type of sampling device being used? Split core barrel

What type of recovery is being obtained? 67%

Were augers and sampling devices decontaminated? Not noted

Are they kept clean? Off ground and on racks

If an alluvial well, did they drill one to three feet into bedrock? N/A

Was any fluid used while drilling? No

If a bedrock well, was the surface casing set into unweathered bedrock? N/A

What type of grout was used to set the casing? N/A

Was the mixture 6 to 9 gallons of water per 94 lbs. of grout? N/A

Was the grout allowed to set for 24 hours? N/A

What size is the core? 2"

Were at least three feet of saturated sandstone found in a ten foot interval of bedrock or was 100' of claystone encountered? N/A

Explain reasons for choosing the total depth if it is different? N/A

Was a packer test conducted? No

Note any drilling problems:

## BOREHOLE LOGGING

Well Number: BH 6-87

Date: June 23, 1987

Audit Performed by: C. Sundblad

Geologist's name: Michael Gard

The field notebook and log of borings from should be filled out in detail. The following items should be found in both.

Borehole number? BH 6-87

Time/date? Yes

Footage? Yes

Recent Recovery? Yes

Material type? Yes

Color? Some

Structural characteristics? N/A

Grain sizes? Yes - diameter estimates on gravel zone

Degree of sorting? Not recorded

Grain shapes? Not recorded

Moisture content? Descriptive

Nature of contacts? Alluvium/bedrock recorded

Organic and radioactive field screening results? Not recorded

Are the cores wrapped in plastic and placed in boxes? Yes

Are the intervals properly identified? Yes

Are the boxes properly identified? Yes

Is the driller keeping a daily log detailing footage drilled, material used, and stand-by time? Yes

Is the geologist (Field Team Leader) doing the same? Yes

## FIELD SCREENING & SAMPLING

BH6-87

Is 50 to 100 ml of soil being placed in 500 ml amber glass jars with equal amounts of deionized water? Not recorded

Is the jar capped, shaken and allowed to stand for 30 minutes? _____

Is each jar labeled with date, time, borehole number, interval? _____

Are the screening instruments calibrated to a specific compound? _____

Are all readings recorded in the field notebook and the log of the borings?

_____

Are designated samples placed in labeled jars and then place on ice in a cooler?

_____

Is the chain of custody form properly filled out? _____

# DRILLING AUDIT

Well Number: BH8-87

Date: 6/22/87

Audit Performed by: C. Sundblad

Geologist's name? K. D. Holliway

Date drilling started? 6/3/87

Type of drill rig being used? Mobile B-57

Proposed formation of completion? Alluvium borehole

Type of sampling device being used? Split core barrel

What type of recovery is being obtained? _____

Were augers and sampling devices decontaminated? Not noted

Are they kept clean? On racks

If an alluvial well, did they drill one to three feet into bedrock? N/A

Was any fluid used while drilling? No

If a bedrock well, was the surface casing set into unweathered bedrock? N/A

What type of grout was used to set the casing? N/A

Was the mixture 6 to 9 gallons of water per 94 lbs. of grout? N/A

Was the grout allowed to set for 24 hours? N/A

What size is the core? 2"

Were at least three feet of saturated sandstone found in a ten foot interval of bedrock or was 100' of claystone encountered? N/A

Explain reasons for choosing the total depth if it is different? _____

Was a packer test conducted? No

Note any drilling problems: _____

## BOREHOLE LOGGING

Well Number: BH8-87

Date: 6/22/87

Audit Performed by: C. Sundblad

Geologist's name: K. D. Holliway

The field notebook and log of borings from should be filled out in detail. The following items should be found in both.

Borehole number? Yes

Time/date? Yes

Footage? Yes

Recent Recovery? Yes

Material type? Yes

Color? Some

Structural characteristics? N/A

Grain sizes? None recorded

Degree of sorting? None recorded

Grain shapes? None recorded

Moisture content? Dry to damp

Nature of contacts? Yes Alluvium/weathered bedrock

Organic and radioactive field screening results? Yes

Are the cores wrapped in plastic and placed in boxes? Yes

Are the intervals properly identified? Yes

Are the boxes properly identified? Yes

Is the driller keeping a daily log detailing footage drilled, material used, and stand-by time? Yes

Is the geologist (Field Team Leader) doing the same? Yes

## FIELD SCREENING & SAMPLING

BH8-87

Is 50 to 100 ml of soil being placed in 500 ml amber glass jars with equal amounts of deionized water? ____ No - clear glass jars were used (see Appendix C)

Is the jar capped, shaken and allowed to stand for 30 minutes? Yes

Is each jar labeled with date, time, borehole number, interval? Yes

Are the screening instruments calibrated to a specific compound? Yes

Are all readings recorded in the field notebook and the log of the borings?
Yes

Are designated samples placed in labeled jars and then place on ice in a cooler?
Yes

Is the chain of custody form properly filled out? Yes

# DRILLING AUDIT

Well Number: BH 9-87

Date: 5/29/87

Audit Performed by: C. Sunblad

Geologist's name? Karen Holliway

Date drilling started? 5/28/87

Type of drill rig being used? Mobile B-57

Proposed formation of completion? Alluvium; concrete backfill

Type of sampling device being used? Splitcore barrel

What type of recovery is being obtained? ~ 80%

Were augers and sampling devices decontaminated? Yes

Are they kept clean? Yes

If an alluvial well, did they drill one to three feet into bedrock? NA

Was any fluid used while drilling? No

If a bedrock well, was the surface casing set into unweathered bedrock? NA

What type of grout was used to set the casing? NA

Was the mixture 6 to 9 gallons of water per 94 lbs. of grout? NA

Was the grout allowed to set for 24 hours? NA

What size is the core? 2"

Were at least three feet of saturated sandstone found in a ten foot interval of bedrock or was 100' of claystone encountered? NA

Explain reasons for choosing the total depth if it is different? NA

Was a packer test conducted? No

Note any drilling problems: None noted

# BOREHOLE LOGGING

Well Number: BH 9-87

Date: 5/29/87

Audit Performed by: C. Sunblad

Geologist's name: Karen Holliway

The field notebook and log of borings from should be filled out in detail. The following items should be found in both.

Borehole number? Yes

Time/date? Yes

Footage? Yes

Recent Recovery? Yes

Material type? Yes

Color? Yes

Structural characteristics? NA

Grain sizes? Descriptive and size range - diameter estimates

Degree of sorting? None noted

Grain shapes? None noted

Moisture content? Descriptive

Nature of contacts? Yes alluvium/bedrock

Organic and radioactive field screening results? Yes

Are the cores wrapped in plastic and placed in boxes? Yes

Are the intervals properly identified? Yes

Are the boxes properly identified? Yes

Is the driller keeping a daily log detailing footage drilled, material used, and stand-by time? Yes

Is the geologist (Field Team Leader) doing the same? Yes

## FIELD SCREENING & SAMPLING

BH 9-87

Is 50 to 100 ml of soil being placed in 500 ml amber glass jars with equal amounts of deionized water? No- clear glass jars were used. See Appendix C.

Is the jar capped, shaken and allowed to stand for 30 minutes? Yes

Is each jar labeled with date, time, borehole number, interval? Yes

Are the screening instruments calibrated to a specific compound? Yes

Are all readings recorded in the field notebook and the log of the borings? Yes

Are designated samples placed in labeled jars and then place on ice in a cooler? Yes

Is the chain of custody form properly filled out? Yes

# DRILLING AUDIT

Well Number: BH 10-87

Date: 6/1/87

Audit Performed by: C. Sunblad

Geologist's name? Karen Holliway

Date drilling started? 6/1/87

Type of drill rig being used? Mobile B-57

Proposed formation of completion? Borehole to be backfilled with concrete

Type of sampling device being used? Splitcore barrel

What type of recovery is being obtained? 40-70% above bedrock contact; below ≈95%

Were augers and sampling devices decontaminated? Yes

Are they kept clean? Yes

If an alluvial well, did they drill one to three feet into bedrock? NA

Was any fluid used while drilling? No

If a bedrock well, was the surface casing set into unweathered bedrock? NA

What type of grout was used to set the casing? Backfill borehole 6 gal/94lbs.

Was the mixture 6 to 9 gallons of water per 94 lbs. of grout? Yes

Was the grout allowed to set for 24 hours? Yes

What size is the core? 2"

Were at least three feet of saturated sandstone found in a ten foot interval of bedrock or was 100' of claystone encountered? NA

Explain reasons for choosing the total depth if it is different? NA

Was a packer test conducted? No

Note any drilling problems:

## BOREHOLE LOGGING

Well Number: BH 10-87

Date: 6/1/87

Audit Performed by: C. Sunblad

Geologist's name: K. Holliway

The field notebook and log of borings from should be filled out in detail. The following items should be found in both.

Borehole number? Yes

Time/date? Yes

Footage? Yes

Recent Recovery? Yes

Material type? Yes

Color? Yes

Structural characteristics? Yes

Grain sizes? Yes - diameter sizes estimated

Degree of sorting? None noted

Grain shapes? Yes

Moisture content? Yes - descriptive

Nature of contacts? Yes

Organic and radioactive field screening results? Yes

Are the cores wrapped in plastic and placed in boxes? Yes

Are the intervals properly identified? Yes

Are the boxes properly identified? Yes

Is the driller keeping a daily log detailing footage drilled, material used, and stand-by time? Yes

Is the geologist (Field Team Leader) doing the same? Yes

## FIELD SCREENING & SAMPLING

BH 10-87

Is 50 to 100 ml of soil being placed in 500 ml amber glass jars with equal amounts of deionized water? No- clear glass jars were used. See Appendix C

Is the jar capped, shaken and allowed to stand for 30 minutes? Yes

Is each jar labeled with date, time, borehole number, interval? Yes

Are the screening instruments calibrated to a specific compound? Yes

Are all readings recorded in the field notebook and the log of the borings? Yes

Are designated samples placed in labeled jars and then place on ice in a cooler? Yes

Is the chain of custody form properly filled out? Yes

# DRILLING AUDIT

Well Number: BH11-87

Date: 6/22/87

Audit Performed by: C. Sundblad

Geologist's name? K. D. Holliway

Date drilling started? 6/2/87

Type of drill rig being used? Mobile B-57

Proposed formation of completion? Alluvium - exploratory borehole

Type of sampling device being used? Split core barrel

What type of recovery is being obtained? _____

Were augers and sampling devices decontaminated? Not noted

Are they kept clean? on rack

If an alluvial well, did they drill one to three feet into bedrock? N/A

Was any fluid used while drilling? No

If a bedrock well, was the surface casing set into unweathered bedrock? N/A

What type of grout was used to set the casing? N/A

Was the mixture 6 to 9 gallons of water per 94 lbs. of grout? N/A

Was the grout allowed to set for 24 hours? N/A

What size is the core? 2"

Were at least three feet of saturated sandstone found in a ten foot interval of bedrock or was 100' of claystone encountered? N/A

Explain reasons for choosing the total depth if it is different? Alluvial borehole

Was a packer test conducted? No

Note any drilling problems: _____

## BOREHOLE LOGGING

Well Number: BH11-87

Date: 6/22/87

Audit Performed by: C. Sundblad

Geologist's name: K. D. Holliway

The field notebook and log of borings from should be filled out in detail. The following items should be found in both.

Borehole number? BH11-87

Time/date? Yes

Footage? Yes

Recent Recovery? Yes

Material type? Yes

Color? Yes

Structural characteristics? N/A

Grain sizes? Some - descriptive

Degree of sorting? Some

Grain shapes? Descriptive

Moisture content? Descriptive

Nature of contacts? Yes, alluvium/weathered bedrock

Organic and radioactive field screening results? Yes

Are the cores wrapped in plastic and placed in boxes? Yes

Are the intervals properly identified? Yes

Are the boxes properly identified? Yes

Is the driller keeping a daily log detailing footage drilled, material used, and stand-by time? Yes

Is the geologist (Field Team Leader) doing the same? Yes

## FIELD SCREENING & SAMPLING

BH11-87

Is 50 to 100 ml of soil being placed in 500 ml amber glass jars with equal amounts of deionized water? No - clear glass jars were used -(see Appendix C)

Is the jar capped, shaken and allowed to stand for 30 minutes? Yes

Is each jar labeled with date, time, borehole number, interval? Yes

Are the screening instruments calibrated to a specific compound? Yes

Are all readings recorded in the field notebook and the log of the borings? Yes

Are designated samples placed in labeled jars and then place on ice in a cooler? Yes

Is the chain of custody form properly filled out? Yes

# DRILLING AUDIT

Well Number: BH 12-87

Date: 6/29/87

Audit Performed by: C. Sunblad

Geologist's name? Michael Gard

Date drilling started? 5/27/87

Type of drill rig being used? Mobile B-57

Proposed formation of completion? Borehole-surface to bedrock, concrete backfill

Type of sampling device being used? Split core barrel

What type of recovery is being obtained? 20% to 95%

Were augers and sampling devices decontaminated? Not recorded in logbook

Are they kept clean? Yes - on racks

If an alluvial well, did they drill one to three feet into bedrock? NA

Was any fluid used while drilling? No

If a bedrock well, was the surface casing set into unweathered bedrock? NA

What type of grout was used to set the casing? Backfill borehole, Portland Type I

Was the mixture 6 to 9 gallons of water per 94 lbs. of grout? Yes

Was the grout allowed to set for 24 hours? Yes

What size is the core? 2"

Were at least three feet of saturated sandstone found in a ten foot interval of bedrock or was 100' of claystone encountered? NA

Explain reasons for choosing the total depth if it is different? NA

Was a packer test conducted? No

Note any drilling problems: Poor recovery - moved and started new borehole

## BOREHOLE LOGGING

**Well Number:** BH 12-87

**Date:** 6/29/87

**Audit Performed by:** C. Sunblad

**Geologist's name:** Michael Gard

**The field notebook and log of borings from should be filled out in detail. The following items should be found in both.**

**Borehole number?** Yes

**Time/date?** Yes

**Footage?** Yes

**Recent Recovery?** Yes

**Material type?** Yes

**Color?** Yes

**Structural characteristics?** Fractures

**Grain sizes?** Yes - diameters estimated

**Degree of sorting?** Not noted

**Grain shapes?** Not noted

**Moisture content?** Yes descriptive

**Nature of contacts?** Yes alluvium/bedrock

**Organic and radioactive field screening results?** Not recorded in logbook

**Are the cores wrapped in plastic and placed in boxes?** Yes, as required

**Are the intervals properly identified?** Yes, as required

**Are the boxes properly identified?** Yes, as required

**Is the driller keeping a daily log detailing footage drilled, material used, and stand-by time?** Yes

**Is the geologist (Field Team Leader) doing the same?** Yes, no standby recorded

## FIELD SCREENING & SAMPLING

BH 12-87

Is 50 to 100 ml of soil being placed in 500 ml amber glass jars with equal amounts of deionized water? Not noted in logbook

Is the jar capped, shaken and allowed to stand for 30 minutes? NA

Is each jar labeled with date, time, borehole number, interval? NA

Are the screening instruments calibrated to a specific compound? Not recorded

Are all readings recorded in the field notebook and the log of the borings? Not recorded

Are designated samples placed in labeled jars and then place on ice in a cooler? Yes

Is the chain of custody form properly filled out? Yes

## BOREHOLE LOGGING

Well Number: BH 13-87

Date: 5/29/87

Audit Performed by: C. Sunblad

Geologist's name: Karen Holliway/ Suzanne Paschke

The field notebook and log of borings from should be filled out in detail. The following items should be found in both.

Borehole number? Yes

Time/date? Yes

Footage? Yes

Recent Recovery? Yes

Material type? Yes

Color? Yes

Structural characteristics? Yes - bedding characteristics

Grain sizes? Yes - diameters estimated

Degree of sorting? None noted

Grain shapes? Yes subrounded to subangular

Moisture content? Yes - descriptive

Nature of contacts? Yes - alluvium/bedrock

Organic and radioactive field screening results? Yes

Are the cores wrapped in plastic and placed in boxes? Yes

Are the intervals properly identified? Yes

Are the boxes properly identified? Yes

Is the driller keeping a daily log detailing footage drilled, material used, and stand-by time? Yes

Is the geologist (Field Team Leader) doing the same? Yes

## FIELD SCREENING & SAMPLING

BH 13-87

Is 50 to 100 ml of soil being placed in 500 ml amber glass jars with equal amounts of deionized water? No- clear glass jars were used. See Appendix C.

Is the jar capped, shaken and allowed to stand for 30 minutes? Yes

Is each jar labeled with date, time, borehole number, interval? Yes

Are the screening instruments calibrated to a specific compound? Yes

Are all readings recorded in the field notebook and the log of the borings? Yes

Are designated samples placed in labeled jars and then place on ice in a cooler? Yes

Is the chain of custody form properly filled out? Yes

# DRILLING AUDIT

Well Number: BH 13-87

Date: 5/29/87

Audit Performed by: C. Sunblad

Geologist's name? Karen Holliway/Suzanne Paschke

Date drilling started? 5/29/87

Type of drill rig being used? Mob Mobile B-57

Proposed formation of completion? Alluvium/colluvium; concrete backfill

Type of sampling device being used? Split core barrel

What type of recovery is being obtained? ~85 - 90%

Were augers and sampling devices decontaminated? Yes

Are they kept clean? Yes

If an alluvial well, did they drill one to three feet into bedrock? NA

Was any fluid used while drilling? No

If a bedrock well, was the surface casing set into unweathered bedrock? NA

What type of grout was used to set the casing? NA

Was the mixture 6 to 9 gallons of water per 94 lbs. of grout? BH 6 gal/94 lb. bay

Was the grout allowed to set for 24 hours? yes

What size is the core? 2"

Were at least three feet of saturated sandstone found in a ten foot interval of bedrock or was 100' of claystone encountered? NA

Explain reasons for choosing the total depth if it is different? NA

Was a packer test conducted? No

Note any drilling problems:

# DRILLING AUDIT

Well Number: BH 13-87

Date: 6/22/87

Audit Performed by: C. Sunblad

Geologist's name? Karen Holliway

Date drilling started? 5/29/87

Type of drill rig being used? Mobile B-57

Proposed formation of completion? Alluvium

Type of sampling device being used? Split core barrel

What type of recovery is being obtained? _____

Were augers and sampling devices decontaminated? Not noted in log book

Are they kept clean? Yes - on racks

If an alluvial well, did they drill one to three feet into bedrock? NA

Was any fluid used while drilling? No

If a bedrock well, was the surface casing set into unweathered bedrock? NA

What type of grout was used to set the casing? NA

Was the mixture 6 to 9 gallons of water per 94 lbs. of grout? NA

Was the grout allowed to set for 24 hours? NA

What size is the core? 2"

Were at least three feet of saturated sandstone found in a ten foot interval of bedrock or was 100' of claystone encountered? NA

Explain reasons for choosing the total depth if it is different? Borehole drilled to define extent of waste contamination in alluvium.

Was a packer test conducted? No

Note any drilling problems: _____

# BOREHOLE LOGGING

Well Number: BH 13-87

Date: 6/22/87

Audit Performed by: C. Sunblad

Geologist's name: K. Holliway

The field notebook and log of borings from should be filled out in detail. The following items should be found in both.

Borehole number? BH 13-87

Time/date? Yes

Footage? Yes

Recent Recovery? Yes

Material type? Yes

Color? Some

Structural characteristics? NA

Grain sizes? Descriptive

Degree of sorting? None noted

Grain shapes? None noted

Moisture content? Descriptive

Nature of contacts? Alluvium/weathered bedrock

Organic and radioactive field screening results? Yes

Are the cores wrapped in plastic and placed in boxes? Yes

Are the intervals properly identified? Yes

Are the boxes properly identified? Yes

Is the driller keeping a daily log detailing footage drilled, material used, and stand-by time? Yes

Is the geologist (Field Team Leader) doing the same? Yes

## FIELD SCREENING & SAMPLING

BH 13-87

Is 50 to 100 ml of soil being placed in 500 ml amber glass jars with equal amounts of deionized water? No- clear glass jars were used. See Appendix C.

Is the jar capped, shaken and allowed to stand for 30 minutes? _____

Is each jar labeled with date, time, borehole number, interval? _____

Are the screening instruments calibrated to a specific compound? Yes

Are all readings recorded in the field notebook and the log of the borings?

_____

Are designated samples placed in labeled jars and then place on ice in a cooler?

_____

Is the chain of custody form properly filled out? _____

# DRILLING AUDIT

Well Number: BH 14-87

Date: 6/29/87

Audit Performed by: C. Sunblad

Geologist's name? Michael Gard

Date drilling started? 5/28/87

Type of drill rig being used? Mobile B-57

Proposed formation of completion? Borehole to bedrock backfill with concrete

Type of sampling device being used? Split corebarrel

What type of recovery is being obtained? 20% to 95%

Were augers and sampling devices decontaminated? Yes

Are they kept clean? Yes, off Ground

If an alluvial well, did they drill one to three feet into bedrock? NA

Was any fluid used while drilling? No

If a bedrock well, was the surface casing set into unweathered bedrock? NA

What type of grout was used to set the casing? Portland Type I for borehole backfill

Was the mixture 6 to 9 gallons of water per 94 lbs. of grout? Yes

Was the grout allowed to set for 24 hours? Yes

What size is the core? 2"

Were at least three feet of saturated sandstone found in a ten foot interval of bedrock or was 100' of claystone encountered? NA

Explain reasons for choosing the total depth if it is different? NA

Was a packer test conducted? No

Note any drilling problems:

# BOREHOLE LOGGING

**Well Number:** BH 14-87

**Date:** 6/24/87

**Audit Performed by:** C. Sunblad

**Geologist's name:** Michael Gard

**The field notebook and log of borings from should be filled out in detail. The following items should be found in both.**

**Borehole number?** Yes - corrected; initially labelled BH 7-87

**Time/date?** Yes

**Footage?** Yes

**Recent Recovery?** Yes

**Material type?** Yes

**Color?** Yes

**Structural characteristics?** Yes - bedding characteristic

**Grain sizes?** Large cobbles

**Degree of sorting?** not noted

**Grain shapes?** not noted

**Moisture content?** descriptive

**Nature of contacts?** alluvium/bedrock

**Organic and radioactive field screening results?** Not noted in logbook

**Are the cores wrapped in plastic and placed in boxes?** Yes, as required

**Are the intervals properly identified?** Yes, as required

**Are the boxes properly identified?** Yes, as required

**Is the driller keeping a daily log detailing footage drilled, material used, and stand-by time?** Yes

**Is the geologist (Field Team Leader) doing the same?** No standby recorded
No concrete volume recorded

## FIELD SCREENING & SAMPLING

BH 14-87

Is 50 to 100 ml of soil being placed in 500 ml amber glass jars with equal amounts of deionized water? No- clear glass jars were used. See Appendix C.

Is the jar capped, shaken and allowed to stand for 30 minutes? _____

Is each jar labeled with date, time, borehole number, interval? _____

Are the screening instruments calibrated to a specific compound? Yes

Are all readings recorded in the field notebook and the log of the borings?

No

Are designated samples placed in labeled jars and then place on ice in a cooler?

As required

Is the chain of custody form properly filled out? As required

# DRILLING AUDIT

Well Number: BH 15-87

Date: June 29, 1987

Audit Performed by: C. Sunblad

Geologist's name? Michael Gard

Date drilling started? 6/2/87

Type of drill rig being used? Mobile B-57

Proposed formation of completion? Borehole to bedrock backfill with concrete

Type of sampling device being used? Split core barrel

What type of recovery is being obtained? 0-100% Abandoned 1st hole D 17'; 2nd hole lost core at same interval

Were augers and sampling devices decontaminated? Yes

Are they kept clean? Yes, off ground

If an alluvial well, did they drill one to three feet into bedrock? NA

Was any fluid used while drilling? No

If a bedrock well, was the surface casing set into unweathered bedrock? NA

What type of grout was used to set the casing? Portland type I - Borehole Backfill

Was the mixture 6 to 9 gallons of water per 94 lbs. of grout? Yes

Was the grout allowed to set for 24 hours? Yes

What size is the core? 2"

Were at least three feet of saturated sandstone found in a ten foot interval of bedrock or was 100' of claystone encountered? NA

Explain reasons for choosing the total depth if it is different? NA

Was a packer test conducted? No

Note any drilling problems:

## BOREHOLE LOGGING

Well Number: BH 15-87

Date: 6-29-87

Audit Performed by: C. Sunblad

Geologist's name: Michael Gard

The field notebook and log of borings from should be filled out in detail. The following items should be found in both.

Borehole number? Yes

Time/date? Yes

Footage? Yes

Recent Recovery? Yes

Material type? Yes

Color? Yes

Structural characteristics? None noted

Grain sizes? Descriptive

Degree of sorting? None noted

Grain shapes? None noted

Moisture content? Descriptive

Nature of contacts? None noted

Organic and radioactive field screening results? Not noted

Are the cores wrapped in plastic and placed in boxes? Yes as required

Are the intervals properly identified? Yes as required

Are the boxes properly identified? Yes as required

Is the driller keeping a daily log detailing footage drilled, material used, and stand-by time? Yes

Is the geologist (Field Team Leader) doing the same? No standby recorded

## FIELD SCREENING & SAMPLING

BH 15-87

Is 50 to 100 ml of soil being placed in 500 ml amber glass jars with equal amounts of deionized water? ~~No- clear glass jars were used. See Appendix C.~~

Is the jar capped, shaken and allowed to stand for 30 minutes? _____

Is each jar labeled with date, time, borehole number, interval? _____

Are the screening instruments calibrated to a specific compound? Yes

Are all readings recorded in the field notebook and the log of the borings?
No

Are designated samples placed in labeled jars and then place on ice in a cooler?
As required

Is the chain of custody form properly filled out? As required

# DRILLING AUDIT

Well Number: BH 16-87

Date: 6/29/87

Audit Performed by: C. Sunblad

Geologist's name? Michael Gard

Date drilling started? 6/2/87

Type of drill rig being used? Mobile B-57

Proposed formation of completion? Borehole to bedrock, concrete backfill

Type of sampling device being used? Split core barrel

What type of recovery is being obtained? 50% - 100%

Were augers and sampling devices decontaminated? Not noted in log book.

Are they kept clean? Yes, offground

If an alluvial well, did they drill one to three feet into bedrock? NA

Was any fluid used while drilling? No

If a bedrock well, was the surface casing set into unweathered bedrock? NA

What type of grout was used to set the casing? Portland Type I - Borehole backfill

Was the mixture 6 to 9 gallons of water per 94 lbs. of grout? Yes

Was the grout allowed to set for 24 hours? Yes

What size is the core? 2"

Were at least three feet of saturated sandstone found in a ten foot interval of bedrock or was 100' of claystone encountered? NA

Explain reasons for choosing the total depth if it is different? NA

Was a packer test conducted? No

Note any drilling problems:

## BOREHOLE LOGGING

Well Number: BH 16-87

Date: 6/29/87

Audit Performed by: C. Sunblad

Geologist's name: Michael Gard

The field notebook and log of borings from should be filled out in detail. The following items should be found in both.

Borehole number? Yes

Time/date? Yes

Footage? Yes

Recent Recovery? Yes

Material type? Yes

Color? Yes

Structural characteristics? Not noted

Grain sizes? Some cobbles noted

Degree of sorting? Not noted

Grain shapes? Not noted

Moisture content? Descriptive

Nature of contacts? Bedrock noted

Organic and radioactive field screening results? Not recorded in logbook

Are the cores wrapped in plastic and placed in boxes? Yes, as required

Are the intervals properly identified? Yes, as required

Are the boxes properly identified? Yes, as required

Is the driller keeping a daily log detailing footage drilled, material used, and stand-by time? Yes

Is the geologist (Field Team Leader) doing the same? Concrete, volume not recorded

## FIELD SCREENING & SAMPLING

BH 16-87

Is 50 to 100 ml of soil being placed in 500 ml amber glass jars with equal amounts of deionized water? No- clear glass jars were used. See Appendix C.

Is the jar capped, shaken and allowed to stand for 30 minutes? _____

Is each jar labeled with date, time, borehole number, interval? _____

Are the screening instruments calibrated to a specific compound? Yes

Are all readings recorded in the field notebook and the log of the borings? No

Are designated samples placed in labeled jars and then place on ice in a cooler? As required

Is the chain of custody form properly filled out? As required

# DRILLING AUDIT

Well Number: BH17-87

Date: 6/22/87

Audit Performed by: C. Sundblad

Geologist's name? K. D. Holliway

Date drilling started? 6/3/87

Type of drill rig being used? Mobile B-57

Proposed formation of completion? Alluvium - Borehole

Type of sampling device being used? Split core barrel

What type of recovery is being obtained? _____

Were augers and sampling devices decontaminated? Yes, previous day

Are they kept clean? Yes on racks

If an alluvial well, did they drill one to three feet into bedrock? N/A

Was any fluid used while drilling? No

If a bedrock well, was the surface casing set into unweathered bedrock? N/A

What type of grout was used to set the casing? N/A

Was the mixture 6 to 9 gallons of water per 94 lbs. of grout? N/A

Was the grout allowed to set for 24 hours? N/A

What size is the core? 2"

Were at least three feet of saturated sandstone found in a ten foot interval of bedrock or was 100' of claystone encountered? N/A

Explain reasons for choosing the total depth if it is different? N/A

Was a packer test conducted? No

Note any drilling problems: _____

## BOREHOLE LOGGING

Well Number: BH17-87

Date: 6/22/87

Audit Performed by: C. Sundblad

Geologist's name: K. D. Holliway

The field notebook and log of borings from should be filled out in detail. The following items should be found in both.

Borehole number? BH17-87

Time/date? Yes

Footage? Yes

Recent Recovery? Yes

Material type? Yes

Color? Yes

Structural characteristics? N/A

Grain sizes? Descriptive (Cobbles)

Degree of sorting? No - not recorded

Grain shapes? Yes

Moisture content? Dry

Nature of contacts? Yes, Alluvium

Organic and radioactive field screening results? Yes

Are the cores wrapped in plastic and placed in boxes? Yes

Are the intervals properly identified? Yes

Are the boxes properly identified? Yes

Is the driller keeping a daily log detailing footage drilled, material used, and stand-by time? Yes

Is the geologist (Field Team Leader) doing the same? Yes

## FIELD SCREENING & SAMPLING

BH17-87

Is 50 to 100 ml of soil being placed in 500 ml amber glass jars with equal amounts of deionized water? __ No - clear glass jars were used (see Appendix C)

Is the jar capped, shaken and allowed to stand for 30 minutes? Yes

Is each jar labeled with date, time, borehole number, interval? Yes

Are the screening instruments calibrated to a specific compound? Yes

Are all readings recorded in the field notebook and the log of the borings?
Yes

Are designated samples placed in labeled jars and then place on ice in a cooler?
Yes

Is the chain of custody form properly filled out? Yes

# APPENDIX F-2

# GENERIC AUDIT FORMS

# Field Audit

Project 881 Hillside

Site Manager _____

Site Location _____

Field Team Leader _____

Auditor C. Sunblad

Date 5/14/87

| Audit Question | Yes | No | Comment/Documentation |
|---|---|---|---|
| 1. Was a site-specific sampling and analytical plan followed? | X | | |
| 2. Was a field team leader appointed? | X | | |
| 3. Was the site health and safety coordinator present? | X | | |
| 4. Were field team members familiar with the sampling plan? | X | | |
| 5. Was a briefing held offsite, before any site work was begun, to acquaint personnel with sampling equipment and assign field responsibilities? | X | | Improvements needed in coordination and communication |
| 6. Was the daily briefing and safety check conducted? | X | | |
| 7. Was a completed "Site Personnel Protection and Safety Evaluation Form" read and signed by all visitors and personnel entering the site? | | X | |
| 8. Was a field notebook assigned to the field team leader? | X | | |
| 9. Were entries made in the field notebook? | X | | |
| 10. Were sampling stations located correctly? | X | | Determined by soil-gas results and field survey. |
| 11. Did the number and location of samples collected follow the site-specific sampling plan? | X | | |

Project _____ Site Manager _____

Site Location _____ Field Team Leader _____

Auditor C. Sunblad Date _____

| Audit Question | Yes | No | Comment/Documentation |
|---|---|---|---|
| 12. Were samples identified as described in the site-specific sampling plan? | | X | Approved deviation |
| 13. Were samples collected following procedures specified in the site-specific plan? | | X | See # 12 |
| 14. Was a chain-of-custody form filled out for all samples collected? Were all sample transfers documented? | X | | |
| 15. Were samples preserved as specified in the site-specific sampling plan? | X | | Where needed |
| 16. Were the number, frequency, and type of samples (including blanks and duplicates) collected as described in the site-specific sampling plan? | X | | |
| 17. Were the number, frequency, and type of measurements and observations taken as specified in the site-specific sampling plan? | X | | |
| 18. Were blank and duplicate samples properly identified? | X | | |
| 19. Was a record maintained of calibration of field equipment? | X | | |
| 20. Was field equipment calibrated as required? | X | | |

Project _____ Site Manager _____

Site Location _____ Field Team Leader _____

Auditor C. Sunblad Date _____

| Audit Question | Yes | No | Comment/Documentation |
|---|---|---|---|
| 21. Have any procedures been revised? | X | | See # 12 |
| 22. Are revisions to procedures adequately documented? | X | | |
| 23. Was the document log for chain-of-custody records and other sample traffic control forms maintained? | | | Uncertain at this point |
| 24. Have any accountable documents been lost? | | X | |
| 25. Did drilling and well construction follow procedures outlined in the sampling plan? | X | | |
| 26. Were the activities being conducted compatible with the environmental conditions? | X | | |

# APPENDIX G

# BIOTA

SOURCE: "USDOE FINAL ENVIRONMENTAL IMPACT STATEMENT, ROCKY FLATS PLANT," DOE-EIS-0064; APRIL 1980.

# LIST OF FLORA AND FAUNA AT ROCKY FLATS

Numerous species of animal and plant life have been identified in the Rocky Flats area. None are classified as rare or endangered.

Rocky Flats floras have been identified (Table A-1) through an on-site inventory by Dr. W. A. Weber, et al., (Weber, 1974), from the University of Colorado. The inventory revealed 327 species of vascular plants, 25 lichens, 16 bryophytes, and one macroscopic green algae.

The species listed in Table A-1 are documented by specimens on permanent file in the University of Colorado Museum herbarium. A second set, complete except for species that were in extremely short supply, was deposited with the management of the Rocky Flats Plant. Duplicate collections of the bryophytes and lichens were not prepared for on-site documentation, however, these specimens are on permanent file in the University of Colorado Museum herbarium.

Table A-1 is divided into four sections: vascular plants, bryophytes, lichens, and macroscopic green algae. The list within each section is arranged alphabetically by species, with the family indicated secondarily. In addition, square brackets are used to identify some species reported by Dr. Whicker of CSU, (Whicker, 1973) but which Weber did not find in his inventory.

Abbreviations used in Table A-1 are as follows:

| | | |
|---|---|---|
| ADV-Adventive | BIEN-Biennial | PER-Perennial |
| AN-Annual | IND-Indigenous | |

Shown in Tables A-2 and A-3 is a listing of fauna at Rocky Flats, which was generated from observations of CSU researchers (Whicker, 1974), and those of a Rocky Flats' biologist (Zillich, 1974). Fish known to occur at Rocky Flats were identified by Zillich (1974) and are listed in Table A-4. Other species of aquatic life within the Plant site were identified by Johnson, et al., (1974), and are also listed in Table A-4.

REFERENCES

Clark, S. J. V. The Vegetation of Rocky Flats, Colorado. Master's Thesis. University of Colorado. Prepared under ERDA Contract No. E(11-1-2371). 1977.

Johnson, J. E., S. Svalberg, and D. Paine. Study of Plutonium in Aquatic Systems of the Rocky Flats Environs. Final Technical Report. Colorado State University, Fort Collins, Colorado. Prepared under The Dow Chemical Company Contract No. 41493-F. June 1974.

Weber, W. A., G. Kunkel, and L. Shultz. A Botanical Inventory of the Rocky Flats AEC Site, Final Report. COO-2371-2. University of Colorado, Boulder, Colorado. Prepared for the U. S. Atomic Energy Commission under Contract No. AT(11-1)-2371, July 31, 1974.

Whicker, F. W. Radiology of Some Natural Organisms and Systems in Colorado. Eleventh Technical Progress Report. Colorado State University, Fort Collins, Colorado. Prepared for the U. S. Atomic Energy Commission under Contract No. AT(11-1)-1156. 1973.

Whicker, F. W. Radiology of Some Natural Organisms and Systems in Colorado. Twelfth technical Progress Report. Colorado State University, Fort Collins, Colorado. Prepared for the U. S. Atomic Energy Commission under Contract No. AT(11-1)-1156. 1974.

Zillich, J. A. Biological Impacts of Rocky Flats Wastes Discharged to Surface Waters. RFP-2210. Dow Chemical U.S.A., Rocky Flats Division, Golden, Colorado. April 9, 1974.

TABLE A-1

PLANTS KNOWN TO OCCUR AT THE ROCKY FLATS SITE

Vascular Plants (327 Species)

ACHILLEA LANULOSA Nutt. "Yarrow" (Compositae). IND PER
AGOSERIS GLAUCA (Pursh) Raf. "False Dandelion" (Compositae). IND PER
AGRIMONIA STRIATA Michx. "Agrimony" (Rosaceae). IND PER
AGROPYRON DESERTORUM (Fisch.) Schult. "Crested Wheatgrass" (Gramineae). ADV PER
AGROPYRON REPENS (L.) P.Beauv. "Quack-Grass" (Gramineae). ADV PER
AGROPYRON SMITHII Rydberg. "Western Wheat-grass" (Gramineae). IND PER
AGROPYRON TRACHYCAULUM (Link) Malte. "Slender Wheat-grass" (Gramineae). IND PER
AGROSTIS GIGANTEA Roth (A.alba of American treatments). "Red-top" (Gramineae). ADV PER
ALISMA PLANTAGO-AQUATICA L. ssp. BREVIPES (Greene) Samuelsson. "Water-plantain" (Alismaceae). IND
PER ALLIUM CERNUUM Roth. "Nodding Onion" (Liliaceae). IND PER
ALLIUM TEXTILE Nels. and Macbr. "Plains Wild Onion" (Liliaceae). IND PER
ALYSSUM ALYSSOIDES L. "Sweet Alyssum" (Cruciferae). ADV
ALYSSUM MINUS (L.) Rothmaler. "Alyssum" (Cruciferae). ADV
AMBROSIA ARTEMISIIFOLIA L. "Roman wormwood" (Compositae). ADV AN
AMBROSIA PSILOSTACHYA DC. "Western wormwood" (Compositae). IND PER
AMBROSIA TRIFIDA L. "Giant Ragweed" (Compositae). ADV AN
AMELANCHIER ALNIFOLIA Nutt. "Shadbush" or "Serviceberry" (Rosaceae). IND
AMORPHA FRUTICOSA L. var. OCCIDENTALIS (Abrams) Kearney and Peebles. "Lead-plant" (Leguminosae). IND
[Amorpha nana.] In the absence of a voucher, we suspect that this is a misidentification of Amorpha fruticosa.
ANDROPOGON GERARDII Vitm. "Big Bluestem" (Gramineae). IND PER
[Andropogon hallii.] We suspect this report to be a misidentification of A.gerardii. A.hallii has not yet been found in the Boulder area and is typical of sand dune areas to the east.
ANDROSACE OCCIDENTALIS Pursh. "Western rock-primrose" (Primulaceae). IND AN
ANEMONE CYLINDRICA Gray. "Thimbleweed" (Ranunculaceae). IND PER
ANTENNARIA PARVIFOLIA Nutt. "Pussytoes" (Compositae). IND PER
ARABIS FENDLERI (Wats.) Greene. "Rock Cress" (Cruciferae). IND PER
ARABIS GLABRA (L.) Bernh. "Tower Mustard" (Cruciferae). ADV BIEN
ARABIS HIRSUTA (L.) Scop. "Hairy Rock-cress" (Cruciferae). IND
ARENARIA FENDLERI Gray. "Sandwort" (Caryophyllaceae). IND PER
ARGEMONE POLYANTHEMOS (Fedde) G.B. Ownbey. "Prickly Poppy" (Papaveraceae). IND BIEN
ARISTIDA BASIRAMEA Engelm. "Harvard Three-awn" (Gramineae). IND AN
ARISTIDA LONGISETA Steud. "Red Three-awn" (Gramineae). IND PER
ARNICA FULGENS Pursh. "Orange Arnica" (Compositae). IND PER
ARTEMISIA CAMPESTRIS L. "Field Wormwood" (Compositae). IND PER
ARTEMISIA DRACUNCULUS L. "Linear-leaved Wormwood" (Compositae). IND PER

TABLE A-1 (continued)

ARTEMISIA DRACUNCULUS L. "Linear-leaved Wormwood" (Compositae). IND PER

ARTEMISIA FRIGIDA Willd. "Pasture Sagebrush" (Compositae). IND PER

ARTEMISIA LUDOVICIANA Nutt. ssp. LUDOVICIANA

ASCLEPIAS SPECIOSA Torr. "Showy Milkweed" (Asclepiadaceae). IND PER

[Asclepias stenophylla.] We undoubtedly overlooked this species, which occurs very sporadically and never occurs in large numbers.

ASCLEPIAS VIRIDIFLORA Raf. "Green Milkweed" (Asclepiadaceae). IND PER

ASPARAGUS OFFICINALIS L. "Asparagus" (Liliaceae). ADV PER

[Aster commutatus crassulus.] = Aster falcatus Lindley. Very late-flowering species which we may well have missed. However, there is also the possibility of a misidentification of Aster porteri.

[Aster ericoides.] See note under A.commutatus. Both species should occur in the area.

ASTER PORTERI Gray. "White Aster" (Compositae). IND PER

ASTRAGALUS ADSURGENS Pall. var. ROBUSTIOR Hook. "Milk Vetch" (Leguminosae). IND PER

ASTRAGALUS BISULCATUS (Hook.) Gray. "Two-grooved Milk Vetch" (Leguminosae). IND PER

ASTRAGALUS CRASSICARPUS Nutt. "Ground-plum" (Leguminosae). IND PER

ASTRAGALUS DASYGLOTTIS Fisch. ex DC. "Milk Vetch" (Leguminosae). IND PER

ASTRAGALUS DRUMMONDII Dougl. ex Hook. "Milk Vetch" (Leguminosae). IND PER

ASTRAGALUS FLEXUOSUS (Dougl.) Don. "Milk Vetch" (Leguminosae). IND PER

ASTRAGALUS SHORTIANUS Gray. "Milk Vetch" (Leguminosae). IND PER

BARBAREA ORTHOCERAS Ledeb. "Winter Cress" (Cruciferae). IND PER

BIDENS CERNUS L. "Nodding Bur-marigold" (Compositae). IND AN

BOUTELOUA GRACILIS (H.B.K.) Lag. "Blue Grama" (Gramineae). IND PER

BOUTELOUA CURTIPENDULA (Michx.) Torr. "Side-oats Grama" (Gramineae). IND PER

BROMUS BRIZAEFORMIS F. and M. "Rattlesnake Grass" (Gramineae). ADV AN

BROMUS INERMIS Leyss. "Smooth Brome" (Gramineae). ADV PER

BROMUS JAPONICUS Thunb. "Japanese Brome" (Gramineae). ADV AN

BROMUS TECTORUM L. "Cheat-grass" (Gramineae). ADV AN

BUCHLOE DACTYLOIDES (Nutt.) Engelm. "Buffalo Grass" (Gramineae). IND PER

CALLITRICHE PALUSTRIS L. "Water Starwort" (Callitrichaceae). IND AN

CALOCHORTUS GUNNISONII Wats. "Mariposa or Sego Lily" (Liliaceae). IND PER

CALYLOPHUS SERRULATA (Nutt.) Raven. "Bushy Evening-Primrose" (Onagraceae). IND PER

CALYSTEGIA SEPIUM (L.) R.Br. ssp. AMERICANUM (Sims) Brummitt. "Hedge Bindweed" (Congolvulaceae). IND PER

CAMELINA MICROCARPA Andrz. "False Flax" (Cruciferae). ADV AN

CAMPANULA ROTUNDIFOLIA L. "Common Harebell" (Campanulaceae). IND PER

CARDARIA DRABA (L.) Desv. "Whiteweed" (Cruciferae). ADV PER

CARDUUS NUTANS L. ssp. MACROLEPIS (Peterm.) Kazmi. "Nodding Thistle" (Compositae). ADV BIEN

CAREX ATHROSTACHYA Olney. "Sedge" (Cyperaceae). IND PER

CAREX AUREA Nutt. "Sedge" (Cyperaceae). IND PER

CAREX BREVIOR (Dewey) Mack. "Sedge" (Cyperaceae). IND PER

TABLE A-1 (continued)

CAREX DOUGLASII Boott in Hook. "Sedge" (Cyperaceae). IND PER
[Carex filifolia.] We suspect that this report refers to Carex oreocharis.
CAREX HELIOPHILA Mack. "Sedge" (Cyperaceae). IND PER
CAREX HYSTRICINA Muehl. "Bottle-brush Sedge" (Chperaceae). IND(?)PER
CAREX INTERIOR L.H. Bailey. "Sedge" (Cyperaceae). IND PER
CAREX LANUGINOSA Michx. "Sedge" (Cyperaceae). IND PER
CAREX NEBRASKENSIS Dewey. "Sedge" (Cyperaceae). IND PER
CAREX OREOCHARIS Holm. "Sedge" (Cyperaceae). IND PER
CAREX PRAEGRACILIS Boott. "Sedge" (Cyperaceae). IND PER
CAREX SCOPARIA Schkuhr. "Sedge" (Cyperaceae). IND PER
CAREX SIMULATA Mack. "Sedge" (Cyperaceae). IND PER
CAREX STENOPHYLLA Wahlenb. ssp. ELEOCHARIS (L.H. Bailey) Hulten. "Sedge" (Cyperaceae). IND PER
CAREX STIPATA Muehl. "Sedge" (Cyperaceae). IND PER
CAREX UTRICULATA Boott. "Sedge" (Cyperaceae). IND PER
CASTILLEJA INTEGRA Gray. "Orange Paintbrush" (Scrophulariaceae). IND PER
CASTILLEJA SESSILIFLORA Pursh. "Plains Paintbrush" (Scrophulariaceae). IND PER
CENCHRUS LONGISPINUS (Hack. in Kneuck.) Fern. "Sand Bur" (Gramineae). IND PER
CERASTIUM ARVENSE L. "Field Mouse-ear" (Caryophyllaceae). IND PER
CERASTIUM FONTANUM Baumg. "Mouse-ear" (Caryophyllaceae). ADV PER
CERASTIUM NUTANS Raf. var. BRACHYPODUM Engelm. "Mouse-ear" (Caryophyllaceae). IND AN
[Cercocarpus montanus.] We did not find this conspicuous shrub and feel obliged to doubt the report.
CHAMAESYCE GLYPTOSPERMA (Engelm.) Small. "Thyme-leaved Spurge" (Euphorbiaceae). IND AN
CHENOPODIUM ALBUM L. "Common Pigweed" (Chenopodiaceae). ADV AN
CHENOPODIUM BOTRYS L. "Jerusalem-oak" (Chenopodiaceae). ADV AN
CHENOPODIUM LEPTOPHYLLUM (Moq.) Wats. "Narrow-leaved Goose-foot" (Chenopodiaceae). IND AN
[Chrysopsis villosa.] This is the same as Heterotheca villosa.
[Chrysothamnus nauseosus pinifolius.] We do not believe that we could have overlooked this conspicuous shrub, and we suggest that this was possibly based on a misidentification of Gutierrezia sarothrae.
CICHORIUM INTYBUS L. "Chicory" (Compositae). ADV PER
CIRSIUM ARVENSE (L.) Scop. "Canada Thistle" (Compositae). ADV PER
CIRSIUM OCHROCENTRUM Gray. "Thistle." IND BIEN
CIRSIUM UNDULATUM (Nutt.) Spreng. "Wavy-leaved Thistle" (Compositae). IND BIEN
CLEMATIS LIGUSTICIFOLIA Nutt. "Western Virgin's-bower" (Ranunculaceae). IND
COLLINSIA PARVIFLORA Lindl. "Baby-blue-eyes" (Scrophulariaceae. IND AN
COLLOMIA LINEARIS Nutt. "Collomia" (Polemoniaceae). IND AN
COMANDRA UMBELLATA (L.) Nutt. "Bastard Toadflax" (Santalaceae). IND PER
CONVOLVULUS ARVENSIS L. "Bindweed; Creeping-Jenny" (Convolvulaceae). ADV PER
CORYPHANTHA MISSOURIENSIS (Sweet) Britt. and Rose. "Nipple Cactus" (Cactaceae). IND PER
CRATAEGUS ERYTHROPODA Ashe. "Hawthorn" (Rosaceae). IND

TABLE A-1 (continued)

CREPIS OCCIDENTALIS Nutt. "Hawksbeard" (Compositae). IND PER

CREPIS RUNCINATA T. and G. "Hawksbeard" (Compositae). IND PER

CUSCUTA APPROXIMATA Bab. "Dodder" (Convolvulaceae). IND AN

CYNOGLOSSUM OFFICINALE L. "Hound's-tongue" (Borginaceae). ADV BIEN

[Cyperus filiculmis.] We doubt that this species occurs in the area, but in the absence of a voucher specimen, we cannot guess what other species might have been mistaken for it.

DACTYLIS GLOMERATA L. "Orchard Grass" (Gramineae). ADV PER

DALEA CANDIDA Willd. "Prairie-clover" (Leguminosae). IND PER

DALEA PURPUREA Vent. "Prairie-clover" (Leguminosae). IND PER

DELPHINIUM NELSONII Greene. "Larkspur" (Ranunculaceae). IND PER

DELPHINUM VIRESCENS Nutt. "Plains Larkspur" (Ranunculaceae). IND PER

DESCURAINIA PINNATA (Walt.) Britt. "Tansy Mustard" (Cruciferae). IND AN

DESCURAINIA SOPHIA (L.) Webb. "Tansy Mustard" (Cruciferae). ADV AN

DODECATHEON PULCHELLUM (Raf.) Merrill. "Shooting-star" (Primulaceae). IND PER

DYSSODIA PAPPOSA (Vent.) Hitchc. "Fetid Marigold" (Compositae). IND AN

ECHINOCEREUS VIRIDIFLORUS Engelm. "Hen-and-chickens" (Cactaceae). IND PER

ECHINOCHLOA CRUS-GALLI (L.) P. Beauv. "Barnyard Grass" (Gramineae). ADV AN

ELEOCHARIS COLORADOENSIS (Britt.) Gilly. "Spike-rush" (Cyperaceae). IND PER

ELEOCHARIS ELLIPTICA Kunth var. COMPRESSA (Sull.) Drap. and Mohl. "Spike-rush" (Cyperaceae). IND PER

ELEOCHARIS MACROSTACHYA Britt. "Spike-rush" (Cyperaceae). IND PER

ELYMUS CANADENSIS L. "Canada Wild-rye" (Gramineae). IND PER

EPILOBIUM ADENOCAULON Hausskn. "Northern Willow-herb" (Onagraceae). IND PER

EPILOBIUM PANICULATUM Nutt. "Panicled Willow-herb" (Onagraceae). IND AN

EQUISETUM LAEVIGATUM A. Br. "Scouring-rush" (Equisetaceae). IND PER

ERIGERON CANUS Gray. "Fleabane" (Compositae). IND PER

ERIGERON DIVERGENS T. and G. "Spreading Fleabane" (Compositae). IND AN BIEN

ERIGERON FLAGELLARIS Gray. "Trailing Fleabane" (Compositae). IND PER

ERIGERON PUMILUS Nutt. "Low Daisy" (Compositae). IND PER

[Erigeron speciosus.] This report must represent a misidentification, most likely of Erigeron strigosus.

ERIGERON STRIGOSUS Muehl. "Daisy Fleabane" (Compositae). ADV AN BAINE PER

ERIOGONUM ALATUM Torr. "Winged Eriogonum" (Polygonaceae). IND PER BIEN

ERIOGONUM UMBELLATUM Torr. "Sulphur-flower" (Polygonaceae). IND PER

ERODIUM CICUTARIUM (L.) L'Her. "Filaree" (Geraniaceae). ADV PER

ERYSIMUM ASPERUM (Nutt.) DC. "Western Wallflower" (Cruciferae). IND BIEN PER

[Euphorbia dictyosperma.] We have only found this species outside the site boundary.

EUPHORBIA MARGINATA Pursh. "Snow-on-the-Mountain" (Euphorbiaceae). IND AN

EUPHORBIA ROBUSTA (Engelm.) Small. "Rocky Mountain Spurge" (Euphorbiaceae). IND PER

FESTUCA PRATENSIS Huds. "Meadow Fescue" (Gramineae). ADV PER

FRASERA SPECIOSA Dougl. "Monument Plant" (Gentianaceae). IND PER

TABLE A-1 (continued)

GAILLARDIA ARISTATA Pursh. "Blanket-flower" (Compositae). IND PER

GALIUM APARINE L. "Cleavers" (Rubiaceae). IND AN

GALIUM BOREALE L. "Northern Bedstraw" (Rubiaceae). IND PER

GAURA COCCINEA Nutt. "Scarlet Gaura" (Onagraceae). IND PER

GENTIANA AFFINIS GRISEB. IND PER

GERANIUM CAESPITOSUM James (G. fremontii of Colorado literature). "Wild Geranium" (Geraniaceae). IND PER

GILIA OPHTHALMOIDES brand ssp. CLOKEYI (MASON) A. and V. Grant. "Gilia" (Polemoniaceae). IND AN

GLYCERIA MAXIMA (Hartm.) Holmboe ssp. GRANDIS (Wats.) Hulten. "American Manna-grass" (Gramineae). IND PER

GLYCERIA STRIATA (Lam.) Hitchc. "Fowl Manna-grass" (Gramineae). IND PER

GLYCYRRHIZA LEPIDOTA (Nutt.) Pursh. "Wild Liquorice" (Leguminosae). IND PER

GRINDELIA SQUARROSA (Pursh.) Dunal. "Gumweed" (Compositae). IND BIEN

GUTIERREZIA SAROTHRA E (Pursh.) Britt. and Rusby. "Snakeweed" (Compositae). IND PER

HARBOURIA TRACHYPLEURA (Gray) C. and R. "Whiskbroom Parsley" (Umbelliferae). IND PER

HEDEOMA HISPIDUM Pursh. "Pennyroyal" (Labiatae). IND AN

HELIANTHUS ANNUUS L. "Common Sunflower" (Compositae). IND AN

[Helianthus petiolaris.] We may have overlooked this species, which is very similar to H. annuus. Both species and hybrids between them occur commonly in the Boulder area.

HELIANTHUS PUMILUS Nutt. "Sunflower" (Compositae). IND PER

HERACLEUM LANATUM Michx. "Cow Parsnip" (Umbelliferae). IND BIEN PER

HETEROTHECA VILLOSA (Pursh.) Shinners. "Golden Aster" (Compositae). IND PER

HEUCHERA PARVIFOLIA Nutt. "Alum-root" (Saxifragaceae). IND PER

HORDEUM JUBATUM L "Foxtail Barley" (Gramineae). IND PER

HYDROPHYLLUM FENDLERI (Gray) Heller. "Waterlead" (Hydrophyllaceae). IND PER

HYMENOPAPPUS FILIFOLIUS Nutt. (Compositae). IND PER

HYPERICUM PERFORATUM L. "Klamath Weed"(Hypericaceae). ADV PER

IPOMOPSIS SPICATA (Nutt.) V. Grant. "Spike Bilia" (Polemoniaceae). IND BIEN

IRIS MISSOURIENSIS Nutt. "Wild Iris" (Iridaceae). IND PER

JUNCUS ARCTICUS Willd. ssp. ATER (Rydb.) Hulten. "Baltic Rush" (Juncaceae). IND PER

[Juncus balticus.] = Juncus arcticus ssp. ater.

JUNCUS BUFONIUS L. "Toad Rush" (Juncaceae). IND AN

JUNCUS DUDLEYI Wieg. "Rush" (Juncaceae). IND PER

JUNCUS NODOSUS L. "Rush" (Juncaceae). IND PER

JUNCUS SACIMONTANUS A. Nels. "Rush" (Juncaceae). IND PER

JUNCUS SPHAEROCARPUS Nees. "Toad Rush" (Juncaceae). ADV AN

JUNCUS TORREYI Cov. "Rush" (Juncaceae). IND PER

JUNCUS TRACYI Rydb. "Rush" (Juncaceae). IND PER

[Kochia iranica.] This is the most abundant ruderal weed in the Boulder area. We did not see it in our inventory, but it probably occurs, most likely in the vicinity of buildings within the security fence.

TABLE A-1 (continued)

KOELERIA GRACILIS Pers. "June Grass" (Gramineae). IND PER

LACTUCA SERRIOLA L. "Prickly Lettuce" (Compositae). ADV AN

LAPPULA REDOWSKII (Hornem.) GREENE. "Beggar's Tick" (Boraginaceae). IND AN

LATHYRUS EUCOSMUS Butters and St. Joh. "Pea-vine" (Leguminosae). IND PER

LEMNA MINOR L. "Duckweed: (Lemnaceae). IND AN PER

LEPIDIUM CAMPESTRE (L.) R. Br. "Field Cress" (Cruciferae). ADV AN

[Lepidium densiflorum.] This undoubtedly occurs as a weed in the area, possibly within the plant enclosure. We did not see it in the area which we covered.

LESQUERELLA MONTANA (Gray) Wats. "Mountain Bladder-Pod" (Cruciferae). IND PER

LEUCANTHEMUM VULGARE Lam. "Ox-eye Daisy" (Compositae). ADV PER

LEUCOCRINUM MONTANUM Nutt. "Sand Lily" (Liliaceae). IND PER

LIATRIS PUNCTATA Hook. "Blazing Star" (Compositae). IND PER

LINARIA DALMATICA (L.) Mill. "Butter-and-eggs" (Scrophulariaceae). ADV PER

LINUM LEWISH Pursh. "Wild Blue Flax" (Linaceae). IND PER

LITHOSPERMUM INCISUM Lehm. "Narrow-leaved Puccoon" (Boraginaceae). IND PER

LOMATIUM ORIENTALE C. and R. "Salt-and-pepper" (Umbelliferae). IND PER

LUPINUS ARGENTEUS Pursh. "Lupine" (Leguminosae). IND PER

LYSIMACHIA CILIATA L. "Fringed Loosestrife" (Primulaceae). IND PER

LYTHRUM ALATUM Pursh. "Winged Loosestrife" (Lythraceae). IND PER

MAHONIA REPENS (Lindl.) G. Don. "Oregon-grape" (Berberidaceae). IND-

MEDICAGO LUPULINA L. "Black Medic" (Leguminosae). ADV PER

MELANDRIUM DIOICUM (L.) Coss. and Germ. "White Campion" (Caryophyllaceae). ADV PER

MELANDRIUM DRUMMONDII (Hook.) Hulten. "Campion" (Caryophyllaceae). IND PER

MELILOTUS ALBA Desr. White Sweet-clover" (Leguminosae). ADV AN BIEN

MELILOTUS OFFICINALIS (L.) Lam. "Yellow Sweet-clover" (Leguinosae). ADV AN BIEN

MENTHA ARVENSIS L. "Field Mint" (Labiatae). IND PER

MERTENSIA LANCEOLATA (Pursh.) A. DC. "Narrow-leaved Mertensia" (Boraginaceae). IND PER

MIMULUS FLORIBUNDUS Doubl. "Monkey-flower" (Scrophulariaceae). IND AN

MIMULUS GLABRATUS H.B.K. "Smooth Monkey-flower" (Scrophulariaceae). IND PER

MONARADA FISTULOSA L. "Pink Bergamot" (Labiatae). IND PER

MUHLENBERGIA MONTANA (Nutt.) Hitche. "Mountain Muhly" (Gramineae). IND PER

MUSINEON DIVARICATUM (Pursh.) Raf. "Musineon" (Umbelliferae). IND PER

MYOSURUS MINIMUS L. "Mousetail" (Ranunculaceae). IND AN

NASTURTIUM OFFICINAL R. Br. (formerly called Rorippa nasturtium-aquaticum [L.] Schinz and Thell.) "Water Cress" (Cruciferae). IND PER

NAVARRETIA MINIMA Nutt. "Navarretia" (Polemoniaceae). ADV (in our area at least) AN

NEPETA CATARIA L. "Catnip" (Labiatae). ADV PER

NOTHOCALAIS CUSPIDATA (Pursh.) Greene. "False Dandelion" (Compositae). IND PER

OENOTHERA BRACHYCARPA Gray. "Yellow Stemless Evening-primrose" (Onagraceae). IND PER

OENOTHERA FLAVA (A. Nels.) Munz. "Evening-primrose" (Onagraceae). IND PER

TABLE A-1 (continued)

OENOTHERA STRIGOSA (Rydb.) Mack. and Bush. "Tall Evening-primrose" (Onagraceae). IND BIEN

ONOSMODIUM MOLLE Michx. var. OCCIDENTALIS (Mack.) Johnston. "False Gromwell" (Boraginaceae). IND PER

OPUNTIA COMPRESSA (Salisb.) Macbr. "Prickly-pear Cactus" (Cactaceae). IND PER

OPUNTIA FRAGILIS (Nutt.) Haw. "Brittle Cactus" (Cactaceae). IND PER

OPUNTIA POLYACANTHA Haw. "Starvation Cactus" (Cactaceae). IND PER

[Opuntia rafinesquei.] = O. compressa.

OROBANCHE FASCICULATA Nutt. "Clustered Cancer-root" (Orobanchaceae). IND AN

OXALIS DILLENII Jacq. "Wood-sorrel" (Oxalidaceae). IND PER

OXYBAPHUS LINEARIS (Pursh.) Robinson. "Narrow-leaved Umbrella-wort" (Nyctaginaceae). IND PER

OXYBAPHUS NYCTAGINEUS (Michx.) Porter and Coulter. "Heart-leaved Umbrella-wort" (Nyctaginaceae). IND PER

OXYTROPIS LAMBERTII Pursh. "Colorado Loco" (Leguminosae). IND PER

PANICUM CAPILLARE L. "Witchgrass" (Gramineae). IND PER

PANICUM OLIGOSANTHES Schult. "Panic-grass" (Gramineae). IND PER

PANICUM VIRGATUM L. "Switchgrass" (Gramineae). IND PER

PARONYCHIA JAMESII T. and G. "Nailwort" (Caryophyllaceae). IND PER

PEDIOCACTUS SIMPSONII (Engelm.) Britt, and Rose. "Mountain Ball Cactus" (Cactaceae). IND PER

[Penstemon angustifolimus.] We suspect this report to be a misidentification of Penstemon virgatus ssp. asagrayi.

PENSTEMON VIRENS Pennell. "Penstemon" (Scrophulariaceae). IND PER

PENSTEMON VIRGATUS Gray ssp. ASA-GRAYI Crosswhite. "One-sided Penstemon" (Scrophulariaceae). IND PER

PERSICARIA LAPATHIFOLIA (L.) S.F. GRAY. "Smartweed" (Polygonaceae). ADV AN

PERISCIARIA MACULATA (Raf.) S.F. Gray. "Lady's Thumb" (Polygonaceae). ADV PER

[Petalostemon purpureus.] = Dalea purpurea.

PHACELIA HETEROPHYLLA Pursh. "Scorpion Weed" (Hydrophyllaceae). IND PER

PHLEUM PRATENSE L. "Timothy" (Gramineae). ADV PER

PHYLA CUNEIFOLIA (Torr.) Greene "Fog-fruit" (Verbenaceae). IND PER

PHYSALIS LOBATA Torr. "Purple-flowered Ground-cherry" (Solanaceae). IND PER

PHYSALIS VIRGINIANA Mill. "Ground-cherry (Solanaceae). IND PER

PHYSOCARPUS MONOGYNUS (Torr.) Coult. "Ninebark" (Rosaceae). IND

PINUS PONDEROSA Laws. var. SCOPULORUM Engelm. "Ponderosa Pine" (Pinaceae). IND

PLANTAGO LANCEOLATA L. "English Plantain" (Plantaginaceae). ADV BIEN PER

PLANTAGO PATAGONICA Jacq. "Woolly Plantain" (Plantaginaceae). IND AN

POA CANBYI (Scribn.) Piper. "Blue-grass" (Gramineae). IND PER

POA COMPRESSA L. "Canada Blue-grass" (Gramineae). IND PER

PODOSPERMUM LACINIATUM (L.) DC. (Compositae). ADV BIEN PER

POLYGONUM DOUGLASII Greene. "Knotweed" (Polygonaceae). IND AN

POLYPOGON MONSPELIENSIS (L.) Desf. "Rabbitfoot Grass" (Gramineae). ADV AN

POPULUS SARGENTII Dode. "Plains Cottonwood" (Salicaceae). IND

POTAMOGETON NATANS L. "Pondweed" (Potamogenonaceae). IND PER

TABLE A-1 (continued)

POTENTILLA FISSA Nutt. "Sticky Cinquefoil" (Rosaceae). IND PER

POTENTILLA GRACILIS Dougl. ex Hook. "Cinquefoil" (Rosaceae). IND PER

POTENTILLA HIPPIANA Lehm. "Woolly Cinquefoil" (Rosaceae). IND PER

PRUNELLA VULGARIS L. "Self-heal; Heal-all" (Labiatae). IND PER

PRUNUS AMERICANA MARSH. "Wild Plum" (Rosaceae). IND

PRUNUS VIRGINIANA L. var. MELANOCARPA (A. Nels.) Sarg. "Choke-cherry" (Rosaceae). IND

PSORALEA TENUIFLORA Pursh. (Leguminosae). IND PER

PYRUS MALUS L. "Apple" (Rosaceae). ADV

RANUNCULUS AQUATILIS L. "Water Crowfoot" (Ranunculaceae). IND PER

[Ranunculus glaberrimus.] We do not believe this occurs on the site, but have no idea what other species might be meant.

RANUNCULUS MACOUNII Britt. "Buttercup" (Ranunculaceae). IND PER

RATIBIDA COLUMNIFERA (Nutt.) Woot. and Standl. "Prairie Cone-flower" (Compositae). IND PER

RHUS TRILOBATA Nutt. "Skunkbrush" (Anacardiaceae). IND

RIBES AUREUM Pursh. "Golden Currant" (Grossulariaceae). IND

[Rorippa islandica.] The report undoubtedly refers to Rorippa palustris ssp. hispida.

RORIPPA PALUSTRIS (L.) Besser ssp. HISPIDA (Desv.) Jonsell. "Yellow-cress" (Cruciferae). IND AN BIEN

ROSA ARKANSANA Porter. "Wild Prairie Rose" (Rosaceae). IND

RUBUS IDAEUS L var. STRIGOSUS (Michx.) Maxim. "Wild Raspberry" (Rosaceae). IND

RUDBECKIA HIRTA L. "Black-eyed Susan" (Compositae). IND PER

RUDBECKIA LACINIATA L. var. AMPLA (A. Nels) Cronquist. "Tall Cone-flower" (Compositae). IND PER

RUMEX ACETOSELLA L. "Sheep Sorrel" (Polygonaceae). ADV PER

RUMEX CRISPUS L. "Curly Dock" (Polygonaceae). ADV PER

RUMEX SALICIFOLIUS Weinm. ssp. TRIANGULIVALVIS Danser. "Willow Dock" (Polygonaceae). IND PER

[Sagittaria cuneata.] We found only S.latifolia, but it is entirely possible that s.cuneata occurs on the site, since they frequently inhabit the same area; they are only distinguishable on examination of mature fruit.

SAGITTARIA LATIFOLIA Willd. "Arrowhead" (Alismaceae). IND PER

SALIX AMYGDALOIDES Anderss. "Peach-leaved Willow" (Salicaceae). IND

SALIX ECIGUA Nutt. "Sand-bar Willow" (Salicaceae). IND

SALIX INTERIOR Rowlee. "Sand-bar Willow" (Salicaceae). IND

SALIX LIGULIFOLIA (Ball) Ball. "Willow" (Salicaceae). IND

[Salsola kali tenuiflora .] This is the common "Russian Thistle," Salsola iberica sennen and Pau. It must be present on the area and we are at a loss to know why we overlooked it.

SALVIA REFLEXA Hornem. "Lance-leaved Sage" (Labiatae). IND AN

SCHEDONNARDUS PANICULATUS (Nutt.) Trel. "Tumble-grass" (Gramineae). IND AN

SCHIZACHYRIUM SCOPARIUM (Michx.) Nash (Andropogon scoparius of older treatments). "Little Blue-stem" (Gramineae). IND PER

SCIRPUS ACUTUS Muehl. "Bulrush; Tule" (Cyperaceae). IND PER

SCIRPUS AMERICANUS Pers. "Three-square" (Cyperaceae). IND PER

SCIRPUS LACUSTRIS L. ssp. VALIDUS (Vahl) Koyama. "Bulrush; Tule" (Cyperaceae). IND PER

[Scirpus microcarpus.] = Scirpus pallidus.

SCIRPUS PALLIDUS (Britt.) Fern. (Cyperaceae). IND PER

SCROPHULARIA LANCEOLATA Pursh. "Figwort" (Scrophulariaceae). IND PER

SCUTELLARIA BRITTONII Porter. "Skullcap" (Labiatae). IND PER

SECALE CEREALE L. "Rye" (Granimeae). ADV AN

SEDUM LANCEOLATUM Torr. "Stonecrop" (Crassulaceae). IND PER

[Senecio atratrus.] This is a species of scree slopes in the subalpine sone and hardly would be expected to occur on the site. Very likely this was a misidentification of Senecio intergerrimus.

SENECIO INTEGERRIMUS Nutt. "Butterweed" (Compositae). IND PER

SENECIO PLATTENSIS Nutt. "Butterweed" (Compositae). IND PER

SENECIO SPARTIOIDES T. and G. "Broom Ragwort" (Compositae). IND PER

SETARIA VIRIDIS (L.) P. Beauv. "Green Bristle-grass" (Gramineae). ADV AN

SILENE ANTIRRHINA L. "Sleepy Catchfly" (Caryophyllaceae). ADV AN

SISYMBRIUM ALTISSIMUM L. "Jim Hill Mustard" (Cruciferae). ADV AN

SISYRINCHIUM MONTANUM Greene. "Blue-eyed-grass" (Iridaceae). IND PER

[Sitanion hystrix.] = Sitanion longifolium.

SITANION LONGIFOLIUM J.G. Smith. "Squirrel-tail" (Gramineae). IND PER

SMILACINA STELLATA (L.) Desf. "False Solomon's Seal" (Liliaceae). IND PER

[Solanum eleagnifolium.] We do not doubt this report. The plant could occur very sporadically in waste ground, but we did not see it.

SOLANUM ROSTRATUM Duanl. "Buffalo Bur" (Solanaceae). ADV (here at least) AN

[Solidago ciliosa.] Highly unlikely for Rocky Flats and probably based on a misidentification of Solidago missouriensis.

SOLIDAGO MISSOURIENSIS Nutt. "Smooth Goldenrod" (Compositae). IND PER

SOLIDAGO MOLLIS Bartl. "Goldenrod" (Compositae). IND PER

SPARTINA PECTINATA Link. "Prairie Cordgrass" (Gramineae). IND PER

SPHAERALCEA COCCINEA (Pursh.) Rydb. "Copper Mallow" (Malvaceae). IND PER

SPOROBOLUS CRYPTANDRUS (Torr.) Gray. "Sand Dropseed" (Gramineae). IND PER

SPOROBOLUS HETEROLEPIS Gray. "Prairie Dropseed" (Gramineae). IND PER

STELLARIA LONGIFOLIA Muehl. "Long-leaved Stitchwort" (Caryophyllaceae). IND PER

STEPHANOMERIA PAUCIFLORA (Torr.) Nees. "Wire-lettuce" (Compositae). IND PER

[Stipa comata Trin.] This species should be in the area, but we did not find it in our survey. We see no reason to doubt the report.

[Stipa neomexicana.] This species should be in the area, and it is very distinctive, but we did not find it in our survey. We see no reason to doubt the report.

STIPA VIRIDULA Trin. "Green Needle-grass" (Gramineae). IND PER

SYMPHORICARPOS OCCIDENTALIS Hook. "Snowberry; Buckbrush" (Caprifoliaceae). IND

SYMPHORICARPOS OREOPHILUS Gray. "Snowberry; Buckbrush" (Caprifoliaceae). IND

TALINUM PARVIFLORUM Nutt. "Fame-flower" (Portulacaceae). IND PER

TARAXACUM OFFICINALE Web. in Wiggers. "Common Dandelion" (Compositae). ADV PER

THELESPERMA MEGAPOTAMICUM (Spreng.) Kuntze. "Green-thread" (Compositae). IND PER

TABLE A-1 (continued)

THERMOPSIS DIVARICARPA A. Nels. "Golden Banner" (Leguminosae). IND PER

[Thlaspi alpestre.] = Thlaspi montanum L. "Candytuft" (Cruciferae). T.alpestre is restricted to Eurasia, although the name has been used until recently for the latter. We do not doubt the report, but we did not find this in our survey.

THLASPI ARVENSE L. "Penny Cress" (Cruciferae). ADV AN

TINIARIA CONVOLVULUS (L.) Webb and Moq. (Bilderdykia convolvulus [L.] Dum.) "Black Bindweed" (Polygonaceae). ADV AN

TOWNSENDIA GRANDIFLORA Nutt. "Easter Daisy" (Compositae). IND BIEN

TOWNSENDIA HOOKERI Beaman. "Easter Daisy" (Compositae). IND PER

TOXICODENDRON RYDBERGII (Small ex Rydb.) Greene. "Poison Ivy" (Anacardiaceae). IND PER

TRADESCANTIA OCCIDENTALIS (Britt.) Smyth. "Spiderwort" (Compositae). IND PER

TRAGOPOGON DUBIUS Scop. "Salsify" (Compositae). ADV BIEN PER

TRAGOPOGON PORRIFOLIUS L. "Purple Salsify" (Compositae). ADV BIEN PER

TRIFOLIUM HYBRIDUM L. "Alsike Clover" (Leguminosae). ADV PER

TRIFOLIUM PRATENSE L. "Red Clover" (Leguminosae). ADV PER

TYPHA LATIFOLIA L. "Broad-leaved Cat-tail" (Typhaceae). IND

VACCARIA PYRAMIDATA Medic. "Cow Cockle" (Caryophyllaceae). ADV AN

VERBASCUM BLATTARIA L. "Moth Mullein" (Scrophulariaceae). ADV BIEN

VERBASCUM THAPSUS L. "Great Mullein" (Scrophulariaceae). ADV BIEN

VERBENA BRACTEATA Lag. and Rodr. "Prostrate Vervain" (Verbenaceae). ADV AN

VERBENA HASTATA L. "Blue Vervain" (Verbenaceae). IND PER

[Veronica americana.] Probably a misidentification of V.anagallis-aquatica, although there is no reason why it could not occur here.

VERONICA ANAGALLIS-AQUATICA L. "Water Speedwell" (Scrophulariaceae). ADV PER

VERONICA PEREGRINA L. "Purslane Speedwell" (Scrophulariaceae). ADV AN

VICIA AMERICANA Muehl. "Common Vetch" (Leguminosae). IND PER

VIOLA CANADENSIS L. "White Violet" (Violaceae). IND PER

VIOLA NUTTALLII Pursh. "Yellow Violet" (Violaceae). IND PER

VULPIA OCTOFLORA (Walt.) Rydb. "Six-weeks Fescue" (Gramineae). IND AN

XANTHIUM STRUMARIUM L. "Cocklebur" (Compositae). ADV AN

YUCCA GLAUCA Nutt. "Spanish Bayonet" (Liliaceae). IND

ZYGADENUS VENENOSUS Wats. var. GRAMINEUS (Rydb.) Walsh ex Peck. "Death Camas" (Liliaceae). IND PER

Lichens (25 Species)

ACAROSPORA FUSCATA (Schrad.) Arn.

ASPICILIA CAESIOCINEREA (Nyl.) Arn.

CALOPLACA LAMPROCHEILA (DC.) Flag.

CANDELARIELLA ROSULANS Muell.-Arg.

CLADONIA PYXIDATA (L.) Fr.

DERMATOCARPON LACHENUM (Ach.) A.L. Sm.

TABLE A-1 (continued)

DIMELAENA OREINA Norm.
DIPLOSCHISTES SCRUPOSUS (Schreb.) Norm.
LECANORA CHRYSOLEUCA (Sm.) Ach.
LECANORA MURALIS (Schreb.) Rabenh.
LECIDEA AURICULATA Th. Fr.
PARMELIA EXASPERATULA (Ach.) Nyl.
PARMELIA SUBDECIPIENS Vain. ex Lynge.
PARMELIA SUBRAMIGERA Gyel.
PARMELIA ULOPHYLLODES (Vain) Savicz.
PARMELIA (XANTHROPARMELIA) indet.
PELTIGERA CANINA (L.) Willd. var.RUFESCENS (Weiss) Mudd.
PHYSCIA ORBICULARIS (Neck.) POETSCH.
PHYSCIA CAESIA (Hoffm. )Hampe.
PHYSCIA DUBIA (Hoffm.) Lett.
PHYSCIA STELLARIS (L.) Nyl.
PHYSCONIA GRISEA (Lam.) Poelt.
RINODINA sp. indet.
SARCOGYNE CLAVUS (Ram. ex Lam. and DC.) Kremp.
XANTHORIA FALLAX (Hepp in arn.) Arn.

Bryophytes (16 Species)

AMBLYSTEGIUM SERPENS (Hedw.) B.S.G. var. JURATZKANUM (Schimp.) Rau et Herv.
BRACHYTHECIUM FENDLERI (Sull.) Jaeg. et Sauerb.
BRYUM ARGENTEUM Hedw.
BRYUM CAESPITICIUM Hedw.
BRYUM CAPILLARE Hedw.
CAMPYLIUM CHRYSOPHYLLUM (Brid.) J. Lange.
CERATODON PURPUREUS (Hedw.) Brid.
DREPANOCLADUS ADUNCUS (Hedw.) Warnst.
GRIMMIA MONTANA B.S.G.
MARCHANTIA POLYMORPHA L.
ORTHOTRICHUM PALLENS Bruch ex Brid.
ORTHOTRICHUM PUMILUM Sw.
PHYSCOMITRIUM PYRIFORME (Hedw.) Hampe.
POHLIA NUTANS (Hedw.) Lindb.
POLYTRICHUM PILIFERUM Hedw.
TORTULA RURALIS (Hedw.) Gaertn.

Macroscopic Green Algae

CHARA species (Characeae).

TABLE A-2

ANIMALS KNOWN TO OCCUR AT THE ROCKY FLATS SITE

Mammals

LEPUS TOWNSENDII - White-tailed Jack Rabbit
SYLVILAGUS spp - Cottontail
SPERMOPHILUS TRIDECEMLINEATUS - Thirteen-lined Ground Squirrel
THOMOMYS TALPOIDES - Northern Pocket Gopher
PEROGNATHUS HISPIDUS - Hispid Pocket Mouse
PEROGNATHUS FLAVUS - Silky Pocket Mouse
PEROMYSCUS MANICULATUS - Deer Mouse
PEROMYSCUS DIFFICILIS - Rock Mouse
MICROTUS PENNSYLVANICUS - Meadow Vole
ONDATRA ZIBETHICUS - Muskrat
MUS MUSCULUS - House Mouse
VULPES FULVA - Red Fox
CANIS LATRANS - Coyote
PROCYON LOTOR - Raccoon
MUSTELA FRENATA - Long-tailed Weasel*
TAXIDEA TAXUS - American Badger
MEPHITIS MEPHITIS - Striped Skunk
ODOCOILEUS HEMIONUS - Mule Deer

BIRDS

ARDEA HERODIAS - Great Blue Heron
ANAS PLATYRHYNOCHOS - Mallard
ANAS STREPERA - Gadwall*
ANAS CYANOPTERA - Cinnamon Teal*
MARECA AMERICANA - Baldpate*
ANAS CAROLINENSIS - Green-winged Teal*
ANAS DISCORS - Blue-winged Teal*
AYTHYA AMERICANA - Redhead*
BUTEO JAMAICENSIS - Red-tailed Hawk
BUTEO LAGOPUS - American Rough legged Hawk*
CIRCUS CYANEUS - Marsh Hawk*
FALCO SPARVERIUS - American Kestrel*
BUTEO REGALIS - Ferruginous Hawk*
CHARADRIUS VOCIFERUS - Killdeer*
COLUMBA LIVIA - Rock Dove*

*Species shown with an asterisk have been seen within the site by a Rocky Flats biologist. All other species were previously identified by Whicker (1974).

TABLE A-2 (continued)

ZENAIDURA MACROURA - Mourning Dove
BUBO VIRGINIANUS - Horned Owl
CHORDEILES MINOR - Common Nighthawk
MEGACERYLE ALCYON - Belted Kingfisher*
SAYORNIS SAYA - Say's Phoebe
AGELAIUS PHOENICEUS - Red-winged Blackbird
EREMOPHILA ALPESTRIS - Horned Lark*
HIRUNDO RUSTICA - Barn Swallow*
PICA PICA - American Magpie
CORVUS CORAX - Raven*
TURDUS MIGRATORIUS - Robin*
STURNUS VULGARIS - Starling*
STURNELLA NEGLECTA - Western Meadowlark
QUISCALUS QUISCULA - Common Grackle*
MOLOTHRUS ATER - Brown-headed Cowbird*
PASSERINA AMOENA - Lazuli Bunting
PIPILO ERYTHROPTHALMUS - Rufous-sided Towhee
POOECETES GRAMINEUS - Vesper Sparrow
MELOSPIZA MELODIA - Song Sparrow*
SIALIA CURRUCOIDES - Mountain Bluebird*
JUNCO HYEMALIS - Slate-colored Junco*
SPEOTYTO CUNICULARIA - Burrowing Owl
CALAMOSPIZA MELANOCORYS - Lark Bunting

---

*Species shown with an asterisk have been seen within the site by a Rocky Flats biologist. All other species were previously identified by Whicker (1974).

TABLE A-3

REPTILES AND AMPHIBIANS KNOWN TO OCCUR AT THE ROCKY FLATS SITE*

RANA PIPIENS BRACHYCEPHALA - Western Leopard Frog*
CHRYSEMYS PICTA - Painted Box Turtle
PHRYNOSOMA DOUGLASSI BREVIROSTRE - Eastern Short-horned Lizard*
THAMNOPHIS RADIX - Plains Garter Snake
COLUBER CONSTRICTOR - Racer
PITUOPHIS MELANOLEUCUS - Common Bullsnake
CROTALUS VIRIDIS - Prairie Rattlesnake

---

*All of these species were identified by Whicker (1974).

TABLE A-4

AQUATIC SPECIES KNOWN TO OCCUR AT THE ROCKY FLATS SITE

Algae

| Cyanophyta (Blue-Green Algae) | Chlorophyta (Green Algae) | Chrysophyta |
|---|---|---|
| GLEOTRICHA | HYDRODICTYON | DINOBRYON |
| GLEOCAPSA | CHLOROCOCCUM | CYMBELLA |
| OSCILLATORIA LIMNOSA | CHLORELLA | HYLOTHECA |
| NOSTOC PRUNIFORME | OEDOGONIUM | NAVICULA |
| ANABAENA | CLADOPHORA | |
| SCYTONEMA | ZYGNEMA | |
| STIGONEMA | ULOTHRIX ZONOTA | |
| TOLYPOTHRIX | CHAETOPHORA | |
| APHANIZOMENON | PEDIASTRUM | |
| APPHITHRIN | SPIROGYRA CRASSI | |
| CALOTHRIX | SPIROGYRA | |
| | SCENEDESMUS | |
| | MOUGEOTIA | |
| | CLOSTERIUM | |
| | EUGLINOIDS | |

| Crustaceans* | Insect Orders* | Fish** |
|---|---|---|
| DAPHNIA PULEX | PLECOPTERA | PIMEPHALES PROMELAS - Fathead Minnow |
| DIATPOMUS | EPHEMEROPTERA | LEPOMIS CYANELLUS - Green Sunfish |
| GAMMARUS | ODONATA | CATOSTOMUS COMMERSONI - Western White Sucker |
| CAMBARUS | DIPTERA | MICROPTERUS SALMOIDES - Largemouth Bass |
| | COLEOPTERA | SALMO GAIRDNERII - Rainbow Trout |
| | TRICHOPTERA | |

* Identified by Johnson, et al (1974)
** Identified by Zillich (1974)